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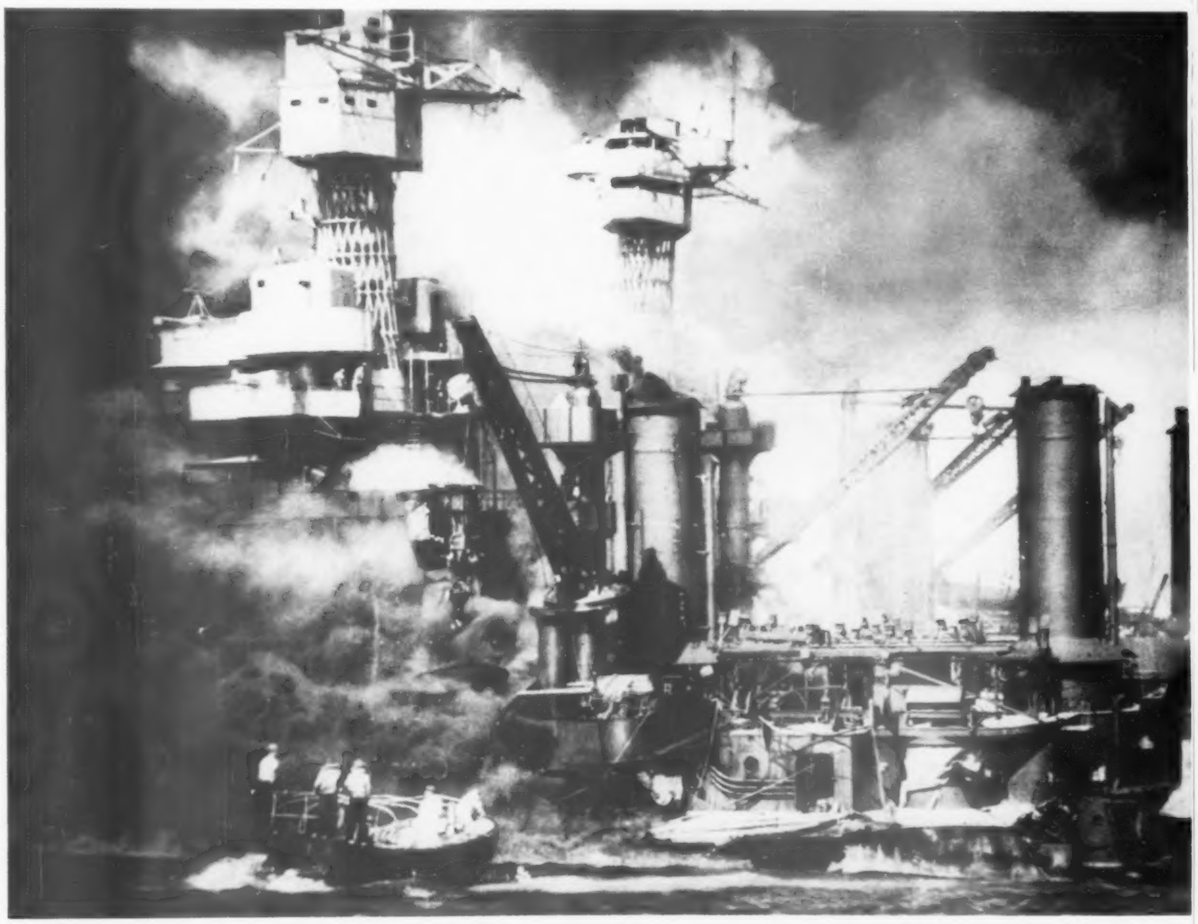
ARMED FORCES CHEMICAL JOURNAL



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NOVEMBER-DECEMBER, 1955

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COVER PHOTO

A scene at Pearl Harbor, December 7, 1941:—Stricken ships blasted in their anchorage; smoke from blazing fuel oil spread over the water; the rescue of a man overboard by a small boat crew. Historic significance combines with artistic composition to make this a picture of exceptional and lasting interest. It is noted that the period of this issue of the JOURNAL includes the fourteenth anniversary of the Japanese surprise naval, air and submarine assault on our fleet and airfields in Hawaii which, with galvanic response from our people, brought this nation into World War II.

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THE NAVY ~

HOST SERVICE FOR BOSTON MEETING OF A.F.C.A. JUNE 14-15, 1956; PLANS SET FOR CRUISE ON AIRCRAFT CARRIER

OFFICIAL U. S. NAVY PHOTOS

U.S.S. Tarawa Underway

THE NAVY HAS graciously accepted the role of host Service for the 1956 annual meeting of the Armed Forces Chemical Association to be held in Boston and environs on June 14-15, with headquarters at the Hotel Somerset.

Mr. Harry A. Wansker, vice president of the Association for meetings, and chairman of the New England Chapter Committee on Arrangements, has received a letter in furtherance of verbal arrangements with the Navy from Captain Richard Lane of the Office of Information, U. S. Navy, Washington, D. C. (It is now established practice of the Association to request one of the Armed Services each year to give a helping hand in the annual meeting program). But from Captain Lane's letter it appears that not only is the Navy to cooperate but has definite plans to take the visiting members of the Association on a demonstration cruise on June 15.

For some time the Boston committee has had such a project in mind, but it is just now able to announce that the arrangements for this are firm, that is, as firm as they possibly can be at this early date. The USS TARAWA, aircraft carrier, has been earmarked for this assignment. Obviously, the provision of this great naval vessel for the cruise indicated will depend upon its availability at the time of the meeting. It seems, however, the hopes of the Boston committee to stage the usual second day afternoon program of the Association aboard a warship at sea have now most excellent prospects of being carried out.

Mr. Wansker states that both Captain Lane and Commander Thomas Quillman will act as project officers in Washington for the Navy's part in the A.F.C.A. meeting arrangements.

It is planned that the visiting members will proceed from Boston by train to the U. S. Navy's station at Quonset Point, R. I., and there board the carrier.

The carrier TARAWA, displacing more than 34,000 tons, was launched in 1945 and was named and christened TARAWA in honor of the United States Marine Corps and in memory of the battle in the Pacific in World War II on Tarawa atoll in which, "the Second Marine Division vanquished the pick of the Japanese fighting men in the fiercest combat in the 168-year history of the United States Marine Corps."

Other plans for the 1956 meeting, as announced in the September-October issue of the Journal, still stand.

It is proposed that the cruise aboard the TARAWA, which will include lunch in the crew's mess, the afternoon symposium, and possibly a showing of Navy films, will return the A.F.C.A. members in time for them to be back to the Hotel Somerset in Boston for the annual reception and banquet.

U.S.S. Tarawa participating in the first airship in flight remanning with Navy blimp.

Herewith, prepared especially for the Armed Forces Chemical Journal, is an authoritative description of the functions and operations of the National Academy of Sciences-National Research Council.—Ed.

THE NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

By Charles I. Campbell

Assistant to the Executive Officer

The National Academy of Sciences-National Research Council holds a unique position in American Science today. It is not a government agency, but the Academy's corporate charter, granted by the Congress of the United States in 1863, designated it as an official adviser to the government. The Academy undertook during World War I to mobilize the scientific and technical resources of the country through the organization of the National Research Council with the confidence and active support of the government. The larger organization of the Academy-Research Council was continued after the war at the request of President Wilson and today more perhaps than ever before it enjoys the active cooperation and support of the government. As a private organization of scientists with important responsibilities as adviser to the government, the Academy-Research Council is thus quite different from the National Science Foundation which is a government agency created to bring to focus government research activities and the policy of the government regarding science, particularly basic science. Accordingly the two organizations often work closely together for the advancement of science in the public interest, but their functions are distinct.

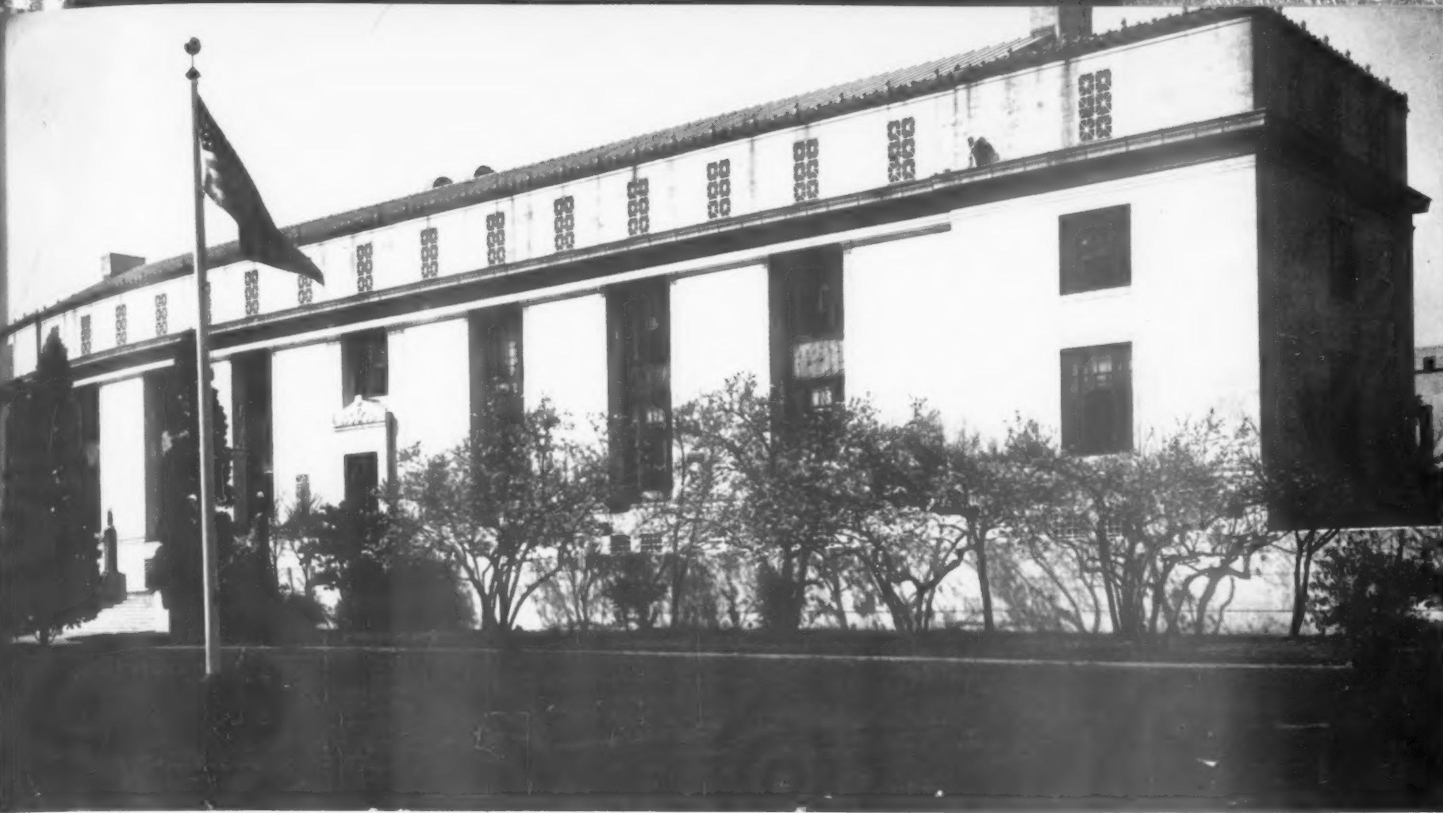
The role of the Academy-Research Council in science and public life today can best be understood in the light of its 92-year history. New and urgent technical problems faced our government during the civil war and forced attention to the fact that this country had no officially recognized body of distinguished scientists to which the government could turn for advice, corresponding to the Royal Society in England, for example, or the Academie des Sciences in France. Accordingly the National Academy of Sciences was established by Act of Congress on March 3, 1863, as a corporation of members named in the Act and originally limited to 50. Its powers were broad including "power to make its own organization . . . (and to provide for) . . . all other matters needful or usual in such institution . . ." But the act also provided that "the Academy shall, whenever called upon by any department of the government, investigate, examine, experiment, and report upon any subject of science or art . . ."

Legal recognition of the metric system in the United States came in 1866 as the result of recommendations of the Academy's first committee, the Committee on Weights, Measures, and Coinage, a committee that has remained in existence during the entire history of the Academy.

Within a month of its incorporation four other advisory committees had been established by the Academy at the request of the government, one of which concerned the new problems of compass compensation aboard iron vessels and one the protection of their bottoms from corrosion by sea water. It is a remarkable commentary on the history of paint chemistry that in 1864 the Academy's committee concluded that no methods for protecting the hulls of iron ships had been proved sufficiently effective to justify recommending their use by the Navy.

By the time of World War I the Academy had grown to over 100 members, but the needs of the government for advice in science and technology had grown even more rapidly. To enable a larger group of the scientists and engineers of the country to join in its program, the Academy organized the National Research Council with the cooperation of President Wilson and his cabinet, the national scientific and engineering societies, research foundations, educational institutions and industrial research laboratories. Through the National Research Council under its first Chairman, George E. Hale, the eminent astronomer, the Academy quickly mobilized the scientific and technical resources of the country. Committees were established in "submarine investigations," "location of invisible aircraft," "chemistry of explosives," "gases used in warfare," "primers," "nitrates and ammonia," and "problems of military training and discipline" to name but a few mentioned in the Council's first Annual Report of 1916. One of the most effective contributions of these committees was an acoustical detection device that saw service before the end of the war in combating the German submarines.

Though the Research Council was established during the war, even then the value of such an association of the scientists and engineers of the country for the furtherance of science and the public welfare in time of peace was recognized. At the close of the war President Wilson requested that the Academy continue the National Research Council, and in his executive order of



Academy of Sciences Building, Washington, D.C. George Lohr Photo

May 11, 1918, he pledged the continued cooperation of the government. He cited the need "to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of strengthening the national defense, and of contributing in other ways to the public welfare."

Today the National Academy of Sciences is comprised of about 540 of the nation's most distinguished scientists and over 50 foreign associates elected to membership in the Academy for their original contributions to the natural sciences. The activities of the Academy-Research Council are made possible by the time and efforts of some 4000 individuals throughout the country who generously devote their skill and time to its programs without compensation except for out-of-pocket expenses. These many individuals work together in committees, boards, panels, institutes and informal groups administered under eight divisions in the fields of anthropology and psychology, biology and agriculture, chemistry and chemical technology, earth sciences, engineering and industrial research, mathematics, medical sciences, and physical sciences. Formally, the members of the National Research Council number about 240 scientists and engineers most of whom are nominated by more than 100 cooperating national societies, but representatives from government scientific bureaus are designated by the President of the United States and there are a limited number of members-at-large. All hold their membership by appointment of the President of the Academy and they are designated as members of the Division corresponding to their field of interest. Their guidance is of assistance to the chairman of their division in carrying out its program.

The chairman of the Division of Chemistry and Chemical Technology is Dr. Frederick D. Rossini, Head of the Department of Chemistry of the Carnegie Institute of Technology. The recent Past Chairman, W. Albert Noyes, Jr., Chairman of the Department of Chemistry at the University of Rochester, is one of the 1955-56 Directors-at-Large of the Armed Forces Chemical Association.

It would be impossible to describe all of the activities of the Academy-Research Council but I shall mention some significant current undertakings and give some detail regarding activities of particular interest to chemists.

Recently the Administration through Governor Adams, Assistant to the President, requested the Academy's advice on problems of loyalty requirements in relation to government support of unclassified research. Government funds are increasingly important to the maintenance of an adequate level of basic research.This makes it imperative that any measures taken in regard to the loyalty of recipients of government grants and contracts for unclassified research be carefully considered to assure that they are consistent with the government's aim of protecting the public interest through the advancement of science. The Academy's committee makes it possible for the government and the scientists of the country to counsel together in solving this important problem.

Recently the Academy-Research Council has been in the public eye in connection with the proposed launching of an earth satellite vehicle. Interesting as this may be it is dwarfed scientifically by the vast international program of geophysical investigations of which the satellite project is but a part. This program is a world-wide yearlong series of observations to be made in 1957 and 1958 termed the International Geophysical Year. The United States' participation in the IGY in which some 40 nations will participate is organized through the Academy-Research Council, which is the organization that adheres on behalf of the scientists of the United States to the International Council of Scientific Unions which sponsored the IGY. The National Science Foundation has collaborated actively by supporting the work of the Academy in this program and by bringing together the interests of various government departments in its many aspects.

Funds have been appropriated by the Congress to support the IGY investigations both in private laboratories and with the facilities of the government, including a Navy-sponsored expedition to the Antarctic.

Chemists will probably be more familiar with the work of one of the constituent unions of the International Council of Scientific Unions, the International Union of Pure and Applied Chemistry, to which the United States also adheres through the Academy-Research Council. It is through this mechanism that American chemists are represented in reaching international agreements on such problems as standards of nomenclature, determinations of fundamental constants, methods of analysis, etc. United States participation in most of the international scientific unions is through the Academy-Research Council.

The Academy has recently undertaken to survey and evaluate the effects of atomic radiation on living organisms, especially man. This very important study was undertaken at the suggestion of the Rockefeller Foundation with its financial support and with the full cooperation of the Atomic Energy Commission.

An activity close to the professional interests of chemists is the Chemical-Biological Coordination Center. This project was established nearly ten years ago to explore the broad relationship of chemical structure to biological activity. Codes suitable for application to punched-card analysis were developed for chemical structures and biological actions and the Center's files now contain coordinated punched-card data on over 50,000 compounds—135,000 individual biological effects—all accessible by modern machine coordinating methods. The CBCC sponsors tests of chemicals and reports its findings in a bi-monthly publication: Summary Tables of Biological Tests. At intervals it publishes accumulated positive data from the tests. The Chemical Corps found the CBCC's system so effective that it arranged to have certain of its own files of chemical data coded and punched by the Center for machine sorting. Recently the Center was requested by the National Heart Institute to extend its interest to cover the word literature on cardiovascular effects of chemicals. It is planned that the accumulated data from this undertaking will be compiled periodically into multi-indexed bibliographies for publication, and the collection itself will be of very great value for research purposes.

The Prevention of Deterioration Center is another activity that compiles chemical data from a particular point of view. Its purpose is to collect and organize in one depository the latest research information on practical techniques for preventing deterioration and to serve in a consulting and advisory capacity on such matters, primarily for the Department of Defense. A by-product of its work is the publication of "Prevention of Deterioration Abstracts" totaling some 2000 pages annually. The Center recently published a book titled "Deterioration of Materials: Causes and Preventive Techniques" (Reinhold Publishing Corp., 1954).

The Department of Defense has requested the Academy-Research Council to establish a Toxicology Information Center as a repository and exchange point for toxicological information as a basis for advice to the military departments and others regarding toxicology and industrial hygiene.

Among the most significant activities of the Academy-Research Council are those involving problems overlapping several scientific fields. An example is a study of the hazards of water transportation of ammonium nitrate, jointly sponsored by the Division of Chemistry and Chemical Technology and the Division of Engineering and Industrial Research at the request of the United States Coast Guard. Attention was focused on this problem by the Texas City disaster. Measures were urgently needed to prevent a recurrence of this tragedy without suspending shipment of ammonium nitrate altogether. The combined efforts of chemists, thermodynamicists, and engineers resulted in an understanding of the explosive hazards of ammonium nitrates upon the basis of which realistic and effective regulations have been issued by the government.

For more than ten years the Army Quartermaster General has turned to the Academy-Research Council's Advisory Board on Quartermaster Research and Development for advise and guidance in formulating a program of research and development and in placing research and development contracts to assist this program. One of the problems considered by the Board for example is the need for specialized elastomers, particularly types suitable for use at subzero temperatures and for high-temperature applications. With the support of the Quartermaster Corps the Board held a conference of scientists interested in elastomer research to direct attention to the particular requirements of military elastomers and to stimulate interest in the fundamental research problems these requirements posed. The proceedings of this conference were published and disseminated widely to promote further work in the field.

The emphasis so far has been on providing advice to the government. This is an important responsibility of the Academy-Research Council but activities in the furtherance of science privately are of equally great importance. There are no doubt few chemists in the world today who have not used the International Critical Tables, but few realize that this great compilation was carried out by the Academy-Research Council with the financial support of the Rockefeller Foundation. The last volume appeared in 1938. Recently steps have been taken toward revising the tables but the enormous volume of physical and chemical data that have been published during the past 25 years makes the matter of publishing a definitive set of critical tables a formidable one. An interdivisional committee has been established under the chairmanship of Dr. A. V. Astin, Director of the National Bureau of Standards, representing chemistry, engineering, physics, and earth sciences, to plan an attack on the problem.

No doubt one of the Academy-Research Council's most effective contributions to science generally has been its fellowships in the natural sciences, particularly at the early postdoctoral level. These have been carried on since 1919 with the financial support of the Rockefeller Foundation and more recently of several other organizations, including Merck and Company, the Lilly Research Laboratories, the Radio Corporation of America, the American Cancer Society and others. The distinction of the National Reserch Council Fellows can be judged from the attainments of the 13 fellows appointed in the first year of the program. Eleven became full professors or chairmen of departments in universities, one chose a government career, one industry. Four were elected to the National Academy of Sciences, two of whom were chemists—Morris Kharasch and W. H. Rodebush. One, Arthur H. Compton, later shared the Nobel Prize in Physics with C. T. R. Wilson. When the government, through the Atomic Energy Commission and later the National Science Foundation, undertook to grant fellowships as a means to assure a continuing high level of scientific man-

(Continued on page 34)

A.F.C.A. TO AWARD $1,000 ANNUALLY FOR SCIENCE TEACHING

The Board of Directors of A.F.C.A. meeting in Washington, D.C., on October 17, 1955, decided to award annually a prize of $1,000 to an outstanding teacher of science in the secondary schools. This action was in furtherance of long-established policy for support of measures to increase technical manpower for national defense. It also reflected the Association's recently expressed views that the roots of the technical manpower problem lie in science education at the high-school level. In the following forthright article, Dr. Brown draws sharply to our attention some alarming facts and figures on the present status of high school science and mathematics education.—Ed.

STARVING OUR POTENTIAL SCIENTISTS

By Kenneth E. Brown, ***Specialist for Mathematics***
Office of Education
U. S. Department of Health, Education and Welfare

Dr. Kenneth E. Brown, Specialist for Mathematics in the United States Office of Education, came to that office in 1952 from the University of Tennessee where he was mathematics consultant to teachers of public secondary schools. A native of Oklahoma, he received his B.S. degree there and holds a Masters degree from the Colorado College of Education and Ph.D. degree from Columbia University.

Dr. Brown is author of the book: "General Mathematics in American Colleges," and for two years he was editor of the section entitled, "Research in Mathematics Education" of the magazine, "The Mathematics Teacher," published by the National Council of Teachers for Mathematics. He is also the author of a number of Office of Education publications on mathematics and science teaching and has given special attention to the problem of insuring an adequate pool of technical manpower in this country.

We are careful to see that the youth of our Nation receive the diet that will develop their bodies. Are we equally concerned about their mental developments? We spend considerable money and provide special coaches in our schools for the athletically gifted. Should we not make even greater provisions for the mentally gifted? Should we force-feed the physically superior and starve the mentally gifted?

The world is engaged in an international conflict—a conflict of ideas. The outcome of this conflict will not depend upon brawn but brains. The United States cannot hope to exceed her opponents in the numbers of unskilled workers or foot soldiers. The superiority must be in terms of greater development of her capable youth. The greatest strength of our nation lies in the undeveloped brains of our youth. Whether we like it or not, we are in a race with the Communists for technological supremacy. We need to re-evaluate the educational opportunities that we are giving our most precious instruments for survival—the youth of our Nation. We must beware lest the struggle for the freedoms we so fondly cherish is lost in the laboratory or conference hall.

The U.S.S.R. is aware of the value of specialized personnel in this atomic age. In 1950 in the U.S.S.R. the number of engineering graduates was 28,000 and last year the number was nearly 50,000. Similar increases are reported in the supply of other specialized personnel and there is evidence that the supply may be rapidly increased.

Does the supply of scientists in the United States show a similar increase? It does not. While the number of graduates from engineering colleges in the U.S.S.R. has increased from 28,000 to 50,000, the number in the United States decreased during this period from 53,000 to 23,000.

The U.S.S.R. is emphasizing the training of technicians—persons with engineering or scientific education but who are not as highly qualified as an engineer or chemist. The U.S.S.R. recently opened 200 technical schools in 150 towns. These schools offered one to two years of training for prospective aids to engineers and scientists. These technicians perform many routine tasks for the engineer or scientist, permitting him to devote more time to creative activities. In the United States for every Ph.D. in chemistry there are six or seven persons with lesser professional training who are indispensable to this scientific team. For our production to increase for war or peace, it will be necessary to have an increase in these supporting technicians.

To what extent are we making progress in increasing our supply of technicians? In a few areas the supply has increased. For example, in the last 50 years the number of health technicians has increased five times as fast as the M.D.'s. Yet this increase was not sufficient to keep up with the demand. In engineering and science the outlook is for a continued shortage of technicians. The United States is graduating about one tenth as many persons in technical courses related to engineering

and science as the U.S.S.R. It is not encouraging, but facts indicate that the annual output of scientific personnel in the United States is decreasing while in the U.S.S.R. it is rapidly increasing. Also, the graduates from the technical institutions in the U.S.S.R. in many cases have had a four-year course compared to the normal two-year course in the United States. The quality of the U.S.S.R. specialized personnel should not be underestimated. It should be obvious that the recent advancement in aviation and nuclear weapons in the U.S.S.R. was not the result of second-rate scientists.

If the advances in medicine, the humanities, and the sciences are to continue at the present rapid rate, the supply of specialists must expand. The annual demand is for 30,000 to 40,000 engineers and only 23,000 were graduated last year. The expenditure for physical research increases each year (4 billion dollars last year) but the number getting Ph.D. degrees in this area decreases. Donald A. Quarles, Assistant Secretary of Defense in charge of Research and Development,* has expressed the need for specialized manpower in these words: "The critical shortage of engineers and scientists in America is potentially a greater threat to our National security than are any weapons known to be in the arsenals of aggressor nations."

College Enrollments Indicate Shortage

A study of college enrollments indicate the shortage of specialized personnel will continue in the foreseeable future. In the United States college enrollments have increased from 2,078,000 in 1946 to 2,499,750 last year. However, during this same period college enrollments in the U.S.S.R. have more than doubled. Best available estimates indicate the number of engineers graduated annually in the United States during the next ten years will be about 30,000. Even if the demand for engineers does not increase, the supply will be insufficient. It is estimated that industry will need 6,000 more scientists and engineers in research and development next year than they needed in 1954. This is in addition to those needed for replacements in production, sales and management. College enrollments indicate similar shortages in other areas. Shortages of 30,000 to 45,000 doctors, 50,000 registered nurses, and 293,000 teachers are in prospect by 1960.

High School Pupils Enrolled in Mathematics and Science

If one looks at our Nation's elementary and secondary schools to study the potential pool of scientific personnel one finds nearly 40 million children. Assuming that the future will be similar to the past, about half of those now in the 5th grade will complete high school and of those high school graduates with ability to succeed in college studies, only about half will go to college. Many of the students who go to college will not have had the high school courses prerequisite for scientific study, even if they desire to pursue it. The training of scientific personnel should begin before the student reaches college. Especially is this true in mathematics. It is difficult, if not impossible, for a college freshman without high school training in mathematics to make up quickly this deficiency. Each year hundreds of college freshmen enroll in noncredit courses, attempting to make up deficiencies in mathematics but the results are most discouraging.

If our supply of specialized personnel has to meet the Nation's demands, more able pupils must receive training in mathematics and science. Reports on present high school enrollments are not encouraging. The number of pupils in high school has increased but the percentage of pupils enrolled in algebra, geometry, physics, and chemistry has decreased.

Percentage of pupils, in the last 4 years of public secondary day schools, enrolled in certain mathematics courses and science courses during 1890-1954

Subject	Years								
	1890[1]	1900	1910	1915	1922	1928	1934	1949	1954[2]
Elementary Algebra	45.4	56.3	56.9	48.8	40.2	35.2	30.4	26.8	24.8
Plane Geometry	21.3	27.4	30.9	26.5	22.7	19.8	17.1	12.8	11.4
Biology			1.1	6.9	8.8	13.6	14.6	18.4	19.8
Chemistry	10.1	7.7	6.9	7.4	7.4	7.1	7.6	7.6	7.3
Physics	22.8	19.0	14.6	14.2	8.9	6.8	6.3	5.4	4.6

[1] Biennial Survey of Education in the United States, 1948-50, Chapter 5, page 107, U. S. Office of Education, Washington, D. C.
[2] Based on a survey in the Fall of 1954 of a 10 percent sample of the public secondary day schools in the United States.

The pupils are avoiding the very subjects that are needed in preparation for scientific careers. Plane geometry is one of the high school subjects normally required for college entrance and as a prerequisite to mathematics or scientific training. The number of pupils taking this subject is less than in 1934. In algebra—the mathematics that is basic to an elementary consideration of quantity in any field of knowledge—the percent of pupils enrolled is less each year. In 1934, 30.4 percent of the high school pupils were enrolled in algebra and last year it was 24.8 percent.

An understanding of science and mathematics is necessary for the potential technician as well as the scientist and yet some of the high schools do not offer these basic subjects. In a survey in the fall of 1954, of a 10 percent randomly selected sample of public secondary day schools, it was found that only about three-fourths of the schools offered plane geometery. Yet this subject is usually a prerequisite for college study. About 10 percent of the high schools did not offer elementary algebra.

The prospective engineer or scientist usually includes solid geometry and plane trigonometry among his high school studies. According to the survey last fall, only 23 percent and 25 percent of the schools were offering solid geometry and plane trigonometry respectively. Thirteen percent of the schools were offering both solid geometry and plane trigonometry. In some schools, plane trigonometry is offered to the 12th grade pupils one semester and solid geometry the other semester. If we assume that those schools that offered one of these subjects in the fall of 1954 offered the other subject in the spring semester, then less than half of the schools offered these subjects last year.

In the area of science, the opportunities for study were not much better according to the survey. In biology, 88 percent of the schools were giving the course. In physics and chemistry only about half of the schools reported they were offering either of the subjects. It should be observed that some small schools combine the 11th and 12th grades and offer 11th grade subjects to the combined class one year and 12th grade subjects to a similar combined class the following year. In such cases, a school may not offer chemistry and physics the same year but it will offer one of these courses. In 1954, according to the survey, one-fourth of the secondary day schools in the United States offered neither physics nor chemistry. Can we expect to nurture the talent of the potential scientist if he has no opportunity to explore in scientific areas?

In the U.S.S.R., explorations in science begin at an early age and in high school 40 percent of the pupil's time is devoted to science and mathematics. In the United

* Recently appointed Secretary of the U.S. Air Force—Ed.

States, many schools require few courses in science and mathematics and pupils do not elect them.

The number of pupils enrolled in mathematics and science decreases from grade to grade. Surveys indicate the number of pupils taking biology is equal to about three-fourths of the pupils on that grade level (10th grade) and the number of pupils taking chemistry is equal to about one-third of the pupils in the 11th grade. The number of pupils in 10th grade mathematics is equal to one-third of the number of pupils in that grade while in the 11th grade it is about one-fourth and in the 12th grade only one-tenth. The higher the grade in high school, the fewer the number of pupils enrolled in science and mathematics.

The need for pupils talented in mathematics and science—the keystone of modern civilization—stands out in bold relief. The enrollments in these subjects are not meeting the demand, yet upon the increase in technically trained personnel depends not only our future standard of living but the very survival of our republic. The struggle for the freedoms we hold so dear may be lost because we failed to give the proper education to our superior youth.

Can the Manpower Supply be Increased?

Is there no hope? There is hope if there is proper action. Undesirable trends can be changed.

School counselors can emphasize the need for more training in mathematics and science for the prospective technician or engineer. Capable pupils can be motivated and guided into courses that will develop their potential in mathematics and science.

Teaching content and procedures can be improved. Recent courses of study in science and mathematics indicate many groups of teachers are revising the curriculum and re-evaluating their teaching procedures for more effective learning.

The interest of teachers in providing better mathematics and science instruction was recognized in a conference held at the U. S. Office of Education, November 13-15, 1952. A group of more than 100 educators, including leaders in government and industry, pooled their ideas on ways of identifying and providing for pupils with potential in science and mathematics. Their suggestions are contained in a pamphlet "The Talented in Mathematics and Science" which is available from the Government Printing Office. The fact that more than 12,000 copies of this report was sold is evidence of the teacher interest in the subject. However, specialized manpower shortage cannot be solved by teacher effort alone. School administrators, parents and leaders in industry must all actively cooperate in immediate action.

Teachers who seek to devote more time to the talented are stymied by large classes. In a randomly selected sample of schools last fall, the average class size in elementary algebra and biology was 28 pupils. In some regions of the United States, 50 percent of the classes are above 30 and many classes contain 45 to 50 pupils. Teacher help to individual pupils is difficult under such conditions. Class size needs to be reduced to permit more individualized instruction. Smaller classes require more classrooms and more teachers. This additional educational investment is necessary if we develop to a maximum our talented youth.

It is true that the shortage of teachers in the elementary school is acute and similar conditions are forecast for the secondary schools. However, the number of teachers can be increased and the quality improved. Some attempts are being made to do this. Industry and educators have cooperated in providing a limited number of pamphlets on the advantage of teaching. Such material is instrumental in encouraging more youth to become teachers.

Industry and educators have cooperated in developing summer workshops and conferences that bring teachers up to date on modern science and methods of teaching the talented in science and mathematics. The summer workshops hold promise as a desirable means of in-service education for science and mathematics teachers. Also a workshop may be conducted on a modest budget. If industry would sponsor only five or six summer workshops or conferences of key teachers in each state and these teachers lead curriculum research projects during the academic year in their own communities, definite improvement in teaching would result. A few conferences of this type have been held and the effective techniques for this type of teacher education are rather clear. Greater support by industry of such workshops would be most welcome by teachers.

Untapped Manpower Pool

The flow of specialists in science and mathematics to the Nation's reservoir of manpower needs to be increased and there is a pool of potential scientists and engineers that can be tapped. For every person who graduates from college there is a capable high school graduate who fails to even enter college. Half of the high school graduates who are in the upper fourth of their graduating classes fail to go to college. Studies indicate that among the most frequent reasons given for the failure of these pupils to attend college is lack of money and their failure to appreciate the value of a college education. Should not schools and industry unite in attempting to alleviate these obstacles?

Many small pamphlets, posters and other printed materials could be made available to teachers, parents and pupils giving, in a concise forceful way, the values to the Nation and to the individual of the maximum education of the superior youth. Information on the importance of developing the potential scientist could be publicized through the press, radio, television and the schools. It would require considerable cooperation and financial support. We spend millions of dollars to educate our citizenry to the value of conserving our physical resources. Should we not inform them of the importance of our most valuable resource—the youth of our Nation?

The Government, industry and labor could unite in providing financial aid for pupils with ability. Capable pupils who need financial assistance should be provided with scholarships. Also, summer employment might be given to pupils with ability to help defray their college expenses. Large sums of money are readily spent to provide stockpiles of defense materials. Should we not spend a little to increase our supply of the most vital instrument of defense—technical personnel?

Grants Needed for Teachers

School administrators and leaders in industry should cooperate in encouraging desirable students to become

teachers. In 1950 approximately 9,000 persons were graduated who were qualified to teach secondary school science and in 1955 the number was less than 4,000. The shortage of teachers will continue to exist until this trend is changed. Three things can and do happen during the teacher shortage:

(1) Some schools employ poorly prepared teachers
(2) Some schools drop science and mathematics courses
(3) Other schools increase the size of the classes.

In any case, the result is poor or no instruction in these vital areas. In view of the shortage of mathematics and science teachers, we are faced with data from studies which show that the teacher is the key figure influencing the pupil in developing his talents in science. Fellowships and scholarships are needed to develop mathematics and science teachers. Such grants would permit hundreds of superior pupils to become teachers and make it possible for poorly prepared teachers to become better qualified by attending summer schools. We must have an efficient core of secondary school science and mathematics teachers or we shall continue to educationally starve our potential scientists.

Action Needed Now

Our supply of scientists and other specialized personnel can be increased by:

(1) More effective guidance in the study of mathematics and science in high school. This implies more information about the importance of mathematics and science in our society should be made available to the parents and pupils. Lay persons could assist by taking part in orientation programs given to high school freshmen and in encouraging industry and labor to produce suitable printed materials for guidance.

(2) The provision of scholarships for any pupils who should attend college and who need financial support. All interested persons could contribute in this area. A single scholarship from an individual, to many grants from industry or the U. S. Government would all be helpful.

(3) The cooperation of education and industry in providing in-service training programs for poorly prepared teachers. The programs might consist of conferences held at regular times during the school year, workshops held during the summer vacation and grants to potentially effective teachers who are academically poorly qualified.

(4) Intensive publicity on our manpower supply and its importance both to the Nation and to the individual. If our citizenry realizes (a) that the supply of engineers and scientists is dangerously low, (b) that there is no prospect for a rapid increase in the near future, (c) the importance of educating our youth to a maximum, then action will be taken. When these facts are known, we will no longer educationally starve our potential scientist, but industry, education and the public will cooperate to provide for his full development. In the meantime, we may ponder the warning of Soviet Communist Party Boss Nikita S. Khrushchev: "We don't have to fight. Let us have peaceful competition and we will show you where the truth lies . . . Victory is ours."

THE ENGINEER'S CONTRIBUTION TO SOCIETY

Talk by
MAJOR GENERAL WILLIAM M. CREASY
Chief Chemical Officer, U. S. Army
Before The Institute of Chemical Engineers
Lake Placid, New York, September 26

IN THE YEAR 1830, only West Point and six-year old Rensselaer Polytechnic Institute at Troy, New York, taught subjects dealing with engineering. That was the extent of technological education among the nation's 56 collegiate institutions.

Now, when I mention the name "Mahan"—M-A-H-A-N—I doubt if many, if any of you recognize it. And probably even those who do are thinking of Alfred Thayer Mahan, who led the American delegation at the first Hague Conference of 1899, after a brilliant career as a Naval strategist.

Few people realize that his father, Dennis Hart Mahan, was just as illustrious in another way—the training of engineers. Much of America's progress can be attributed to the teachings and actions of the elder Mahan. He took as raw ingredients, the fertile, young minds of West Point cadets; and in them, he instilled a system of thinking along engineering principles. His students contributed heavily to the nation through inventiveness, construction, exploration, education, and leadership.

Today, the name of Alfred Thayer Mahan is a military byword, while that of his father, Dennis Hart Mahan, is almost forgotten. The elder Mahan entered the Academy in 1818, just 16 years after its establishment. The idea for the school was first conceived by George Washington, who, at the close of the Revolutionary War, saw the need for a corps of trained militia officers if the young nation was to preserve its freedom. He suggested West Point as the site. But it was not until 1802 that the U. S. Military Academy at West Point was established. It was to be supervised by the new Corps of Engineers.

When Mahan entered the Academy it was still not much more than a "school for young gentlemen." There was an engineering slant to its course, but the teaching along this line was meager. Mahan had such a brilliant mind that within a few months he was doing double-duty—serving as a mathematics instructor while still a cadet. When he graduated, Mahan was assigned to West Point as a professor in engineering and mathematics.

HOWEVER, he—and others—felt that the school lacked a great deal in its teachings, and he prevailed upon the War Department to send him to Europe to study and pick up ideas. He returned from Europe as a well-trained—for those times—engineer and much informed. Among the things he brought back with him was the method of lithographic printing, and an idea for banking railroad curves as a safety measure. His influence on the Academy was such that it became the acknowledged fountain-head of engineering education in the United States—the scene of the first systematic study of science in this country. West Point is not only a great institution; but it is unique, for its contributions to the growth of America are almost beyond calculation. This is especially true for the period prior to 1900. During the 19th Century, Uncle Sam was building his nation; and, as dictated by necessity, he reached for, and used, the only technological tool then available—the West Point product.

I cannot attempt to list all of the contributions West Point and its graduates made to a growing nation, but I will cite some of the lesser known contributions which have had a varied social impact. For instance, education.

In 1800, two years before West Point was founded, our nation had 22 colleges and universities. All of them taught only the liberal arts. Engineering, as a study, was unknown. This condition continued for years. But the digging of the Erie Canal in 1825, and word of technical advancements in Europe, led to a growing realization that one of the nation's great needs was technological study. During the 1830's, academic institutions had increased to 56 on the collegiate level. In nine of these schools, located in eight states, West Pointers were teaching engineering and mathematical subjects. By 1860, our nation had 203 colleges and universities, and 38%, located in 21 states, had West Pointers on the staffs and faculties. The rapid expansion continued, and by 1900, the Academy's influence was being felt throughout the educational system. Its graduates headed many of the schools' mathematics and engineering departments, or in a number of cases, had become presidents of these institutions of higher learning. And, in those schools where engineering sciences were studied, Mahan's published lectures as a West Point professor were used as standard texts. Thus we must recognize the fact that although today the name "Mahan" may mean little to the student of engineering, what he is learning is, to a certain degree, the outgrowth of Mahan's original teachings.

TO SUM UP the situation I might cite what Riedler says in his book, "American Technological Schools." I quote:

"Engineering as a profession dates back no further than 1850. Its first beginning may have been as early as 1830 . . . Before 1840, real instruction in engineering was offered almost exclusively in the Military Academy at West Point. Up to 1840, even up to 1850, nearly all civil engineers had received their preparation in this military school . . ." (end of quote).

We must remember that today's vast and varied engineering field stems from the single subject of civil engineering; for until the Industrial Revolution, this was the only form of engineering. Man's use of the machine has led to the new fields of chemical, mechanical, elec-

trical, textile, ceramic, plastics, and other forms of engineering.

Today, man is starting to explore outer space. But in the early 1800's, Americans were still exploring the North American continent. By 1832, such men as Lewis and Clark, Zebulon Pike, Stephen Long—all Army men operating under orders—had taken exploratory peeks at the great unknown West. But it was West Pointer Benjamin Louis deBonneville of the class of 1815, who provided the first sound basis for westward expansion. Granted a leave of absence by the Army, he headed west as a trader. In three years, he and his party covered the area roughly bounded by the great Salt Lake in the east, the Columbia River in the north, and California's San Joaquin River on the south. They returned with a comprehensive and geographical survey of the west which for the first time really lifted the curtain on the potentialities of the natural resources of that area.

President John Quincy Adams saw the vital need for better communications and ordered the War Department to give "every aid possible" in furthering the growth of highways and railroads. This meant the detailing of officers to as many projects as possible.

William Gibbs McNeill of the class of 1817, and George Washington Whistler, class of 1819, were given leave to help build the Baltimore and Ohio Railroad, America's first passenger railroad. The two officers surveyed and started construction of the new line. However, Whistler was more mechanically-minded and found a need for his talents in the engine development field. Although he gave his name to one of his inventions, the locomotive whistle, the name "Whistler" is generally connected with a famous painting done by his son.

By the turn of the 20th Century, more than threescore West Pointers had been chief engineers for railroads constructed, and 22 had become presidents of lines.

Other graduates of West Point found a corollary between the logical and creative thinking developed by engineering studies and the conscientious and inspirational thinking of religion. Such thoughts were generated by the chaplains at the Academy, and many of the graduates turned to religious works and became leaders in American religion. For instance, James Clark, class of 1826, became an influential leader in the building of the Catholic education system. He had a hand in the growth of such schools as Georgetown University, Holy Cross, and Gonzaga.

Francis Vinton graduated from West Point in 1830. Six years later he resigned his commission to study for the ministry. As a climax to a successful career as a clergyman, he was appointed Ludlow Professor of Ecclesiastical Policy and Canon Law in the General Theological Seminary—one of the most responsible positions in the Protestant Episcopal Church in this country.

Others found that missionary work among the Indians was rewarding.

During the War Between the States, young Peter Smith Michie, class of 1863, won renown for his brilliant work as chief engineer for the Army of the James. Today, however, his military record is all but forgotten. His name, though, is frequently mentioned in research; for his treatise on "Elements of Wave Motion, Relating to Sound and Light" became a stepping stone on the long pathway of research that led to the electronics of today.

Henry Mertyn Roberts, an 1857 graduate, used his engineering talents to build navigational aids on Lake Michigan and the West Coast. He was also an accomplished public speaker and he found that every community had its own "ground rules," and every meeting chairman had his own thoughts on parliamentary procedure. So, in his spare time, he started compiling a list of standard rules of parliamentary methods. Today, no high school debate, no lodge meeting, no United Nations deliberation, is held without a copy of Robert's Rule of Order within reach of the chairman.

George Owen Squier graduated from the Academy in 1887. On September 12, 1907, he was the first passenger flown in a plane piloted by the Wright brothers. Squier, serving as a Signal Corps officer, became what we might call the "Midwife" for military aviation. He drew up the first specifications for a military airplane, led the fight to use planes in military operations, and nursed the infant air arm into a separate service during, and after, World War I. He also found time to delve into electronics, and invented the Squier standard multiplex system which makes possible ten or more simultaneous telephone or telegraph conversations on one circuit. He also invented the monophone system of harnessing radio broadcasts to commercial telephone circuits, which made possible our great transcontinental radio networks.

Edward S. Holden graduated with the class of 1870, and stayed on at West Point to teach philosophy and engineering for two years. Then he joined the staff of the Naval Observatory and soon drew international attention. During an eclipse of the sun he was able to take photographs showing the corona to a distance of fifty feet from the moon's limit. Later he became president of the University of California, but stepped down to take charge of the school's observatory project. He designed the buildings and instruments of the $700,000 Lick Observatory atop Mount Hamilton in California—in its day, the world's finest. Holden is also noted for his research writings on such varied subjects as astronomy, development of the infant mind, children's vocabularies, ancient Asiatic history, mathematics, an analysis of modern literature, and radioactivity.

The habit of logical thinking instilled in the engineering mind led many into the diplomatic field. There was, for instance, John McAllister Schofield, class of 1853, who chased Napoleon's puppet empire out of Mexico without firing a shot. Schofield had 50,000 troops massed on the Texas-Mexican border ready to help the

Mexican republicans in ousting Maximilian. However, he was recalled to Washington and given a special mission by Secretary of State William H. Seward. Seward told Schofield, and I quote:

"I want you to get your legs under Napoleon's mahogany, and tell him he must get out of Mexico!" (end of quote).

Using the same astuteness that had already won him military acclaim, Schofield carried out his mission, and thus averted another war without firing a shot and without raising Napoleon's ire.

Then there is Leslie Richard Groves, class of 1918, who failed to earn his letter as a varsity football player at West Point, but went on to earn his "A," as a scientific administrator through his leadership in the war-time Manhattan Project.

These are but a few random examples of the contributions West Point, and its men, have made to America in a non-military sense. My point is that the teaching at West Point is basically one of engineering. It teaches young men to think as engineers; to think clearly, analytically, imaginatively, and with celerity.

There is an old saying among the military, "Give a West Pointer a job to do, and when he comes back he has the package with him, neatly wrapped up."

Personally, I feel that this description very aptly fits most of the young men engaged in today's engineering profession, for they have received the same type of training as the West Pointer—in an engineering sense.

Up until the turn of the 20th Century, our nation looked to its Army engineers to guide much of its progress, since West Point was the seat of learning in the technical fields, and the work was not as broad and specialized as it is today. Today, however, this role has been taken over by the MIT's, the Purdue's, and the Stanford's of our nation, and their graduates.

Of the nearly 500 generals in the Regular Establishment, nearly 20 percent have advanced degrees beyond those earned upon graduation from West Point or a civilian college. Since advanced degrees are required in the medical profession, these were not included in this percentage figure.

Of that 20 percent group, 75 percent have advanced degrees in the engineering fields. And, incidentally, the one school represented the most in this group is MIT. Carrying the search even further, it was found that 10 percent of the generals had had military engineering experience, either as members of the Corps of Engineers, or through attendance at Army engineering courses other than the four-year course at West Point. And, in this group, there were only 10 generals who had not earned advanced degrees.

On the Department of Army's Pentagon level, one out of every four general officers working in non-engineering assignments has either an advanced degree in engineering or has had military engineering experience. To keep this figure realistic, those officers assigned to the Corps of Engineers, the Chaplains Corps, and the Medical Corps were excluded from consideration.

Now, I am not implying that an advanced degree in engineering, or military engineering experience, is a prerequisite for promotion to general's rank, but I am using this means to show how this type of training does help in promotional advancement.

Men like Maxwell Taylor, the Army Chief of Staff; Charles Bolte, the former Army Vice Chief of Staff; Arthur Trudeau, the former Army Chief of Intelligence; Donald Booth, Army Assistant Chief of Staff for Personnel; Eugene Caffey, the Army Judge Advocate General; or Bruce Clark, who commands our Army forces in the Pacific—all holders of advanced engineering degrees or experienced in military engineering—have used the type of thinking generated by engineering training to further their leadership ability.

Incidentally, I might add here, the fact that three out of the four general officers in the Chemical Corps hold advanced degrees in chemical engineering—all earned at MIT.

Naturally, I can't stand before you and not put in a small "commercial" for the organization I represent. The Chemical Corps has always been proud of its engineering people. In a unique and difficult field they have overcome many challenges as we seek to harness the power of chemical and biological energy.

The Chemical Corps has the specific responsibility of studying the toxicological fields of chemical, biological and radiological warfare in order to provide our nation with a capability in all three areas.

We are a unique organization in that our work must be integrated not only into the military preparedness program, but also into the passive civil defense plan. This means that we must work closely with the Army, Navy and Air Force, and at the same time collaborate with the U.S. Public Health Service and the Federal Civil Defense Administration, whenever it appears feasible.

To adequately perform this mission, we must integrate the civilian scientist and engineer into our program of military research. This is not easy, for we must compete with industry to hire people. A great deal of credit is due to those who forsake the comparatively higher wages of industry to join us. On the other hand, while working in the government may have some drawbacks, it offers many advantages. For instance, the young engineer can continue his studies while working for us and earn a collegiate advanced degree—as many have in the past few years—from one of our four Universities that work with us on this educational program. Then too, our research program is so broad and varied that the scientist or engineer has a wide range of fields in which to work.

In our Chemical and Radiological Laboratories, one of the keystone agencies in our research and development program, more than a thousand civilians are employed; 51 percent are engineers, and 24 percent are chemical engineers.

It is pretty well established that thinking tends to stagnate if limited to one small group for a long period of time. To overcome this tendency, we are contracting out more than one-third of our research work to civilian institutions and industries. In this way, we utilize the best brains and talents in the nation. It is a method of integrating all of you into our military research program with all-round benefits.

The results of our research, whether done within our own establishment, or under contract, have been two-fold. The direct results have been advancements in military equipment. The indirect results have been items

(Continued on page 17)

OBITUARIES

COL. SAMUEL N. CUMMINGS

COL. SAM CUMMINGS

Colonel Samuel N. Cummings, 61, retired officer of the Chemical Corps reserve, consultant on coal tar colors and a former vice president of the Armed Forces Chemical Association, died on September 30. He had resided at 225 Eastern Parkway, Brooklyn. His office was at 799 Greenwich Street, New York City. Since 1919 he had been president of the Pylam Products Co., engaged in the production and distribution of coal tar dyes. Funeral services were held on October 2 at Riverside Memorial Chapel, Brooklyn, and burial was at the Wellwood Cemetery, Farmingdale, L. I.

Long active in reserve affairs, Colonel Cummings was a veteran of both World Wars I and II. At the time of his retirement from the active reserve about a year ago he was Commanding Officer of Mobilization Designation Detachment No. 10 (New York Chemical Procurement District). On that occasion his comrades of No. 10, together with many Chemical Corps friends on active duty, joined in a reception and dinner in his honor.

In addition to his connection with the New York procurement office of the Chemical Corps for reserve matters, Colonel Cummings had had extensive experience there. He served two periods of duty in that office during World War II, these alternating with tours of duty in the Industrial Division of the Chief's office in Washington. He received high commendation for his work in procurement for the Chemical Corps and upon his relief from active duty in 1946 he was awarded the Legion of Merit for outstanding service.

Colonel Cummings was born in 1894. He attended New York University, completing a 4-year scholarship, and received a degree in organic chemistry. During World War I he served overseas in the Flanders, Lorraine and Vesle River campaigns as Gas Medical Defense Unit sergeant and later as an instructor in gas defense.

Colonel Cummings was considered an authority on off-color petroleum products and coal tar colors. He had acted as consultant in chemical processing matters for a number of large corporations.

In addition to his work in the chemical and military fields, Colonel Cummings had been active in civic affairs since 1912. He had been made a Life Director of the Junior Chamber of Commerce, had been chairman of the Brooklyn Chamber of Commerce Committee for Underprivileged Children, member of the Boys' Work Council, and secretary of the Boys' Welfare Foundation, a coordinating group for social service work with boys in Brooklyn.

DONALD B. BRADNER

Mr. Donald B. Bradner, chemical engineer, widely known in chemical circles of this country, former officer of the Chemical Warfare Service, and later chief chemist of the Service, died at his home, 1616 Sixteenth Street, N.W., Washington, D. C., on September 30.

Mr. Bradner was born in Marion, Indiana, on November 25, 1891. He was educated at the University of Nevada and was engaged as a chemical engineer with mining concerns until World War I, when in 1918 he became associated with the U. S. Bureau of Mines. In that same year he was commissioned a captain in the Chemical Warfare Service and served in that capacity until 1922 when he reverted to civilian status. He was then made chief chemist of the Service.

In 1924 Mr. Bradner engaged as a chemical engineer with the E. I. duPont de Nemours & Co., Inc., and in 1926 he became director of research and development of the Hamilton Laboratories of the Champion Paper and Fiber Company. In 1933 he was made vice president and general manager of the Hamilton Laboratories. In 1942 he returned to the Chemical Warfare Service as special advisor to the Chief, serving in that capacity until 1944 when he became a consultant of the DuPont Company.

Mr. Bradner held over 50 patents. He was a member of the American Institute of Chemical Engineers, American Chemical Society, the Technical Association of the Pulp and Paper Industry, the American Academy for the Advancement of Science, and the Armed Forces Chemical Association.

Graveside services and burial were held at the Arlington National Cemetery.

DR. GEORGE AUGUSTUS HULETT

Dr. George Augustus Hulett, 88, one of the pioneers in the organization of the Chemical Warfare Service in World War I, died on September 6 at Princeton, N. J.

Dr. Hulett was professor emeritus of physical chemistry at Princeton. He was born at Ranch, Ill., on July 15, 1867. He obtained an A.B. degree from Princeton in 1893 and later studied at the University of Leipzig, where he received his Ph.D. degree.

Dr. Hulett was one of the 1917 Gas Warfare Research Group pictured in the September-October issue of the Journal.

HARRY L. MOAT

Members of the Wilmington Chapter of A.F.C.A., as well as many other members of the Association who knew Mr. Harry L. Moat, were shocked at the news of his sudden death in Wilmington on June 12 last.

Mr. Moat was director of production for the Atlas Powder Company at Wilmington. He was a native of Catasauqua, Pa., and a graduate of Pennsylvania State College and member of Phi Beta Kappa and Alpha Zeta honorary fraternities.

He started to work with Atlas on graduation, first at the company's Perryville, Maryland plant, and came to Wilmington in 1931.

Mr. Moat was a member of a number of professional and social organizations and was president of the Pennsylvania State Alumni Association of Delaware.

DAVID CRAMPTON

Mr. David Crampton, Chief Chemical Engineer of Wallace & Tiernan Incorporated, Belleville, N. J., and a member of A.F.C.A., was drowned on August 28 at Mantoloking, N. J. when caught in a heavy undertow.

Mr. Crampton, who had been with the company for 24 years, was a graduate of Cornell University. He held a number of patents in the field of water treatment and was a recognized authority on refrigeration.

He was a member of the American Chemical Society, American Society of Oil Chemists, and the American Society of Refrigeration Engineers.

ENGINEER'S CONTRIBUTION TO SOCIETY

(Continued from page 14)

or ideas that can be integrated into normal every-day life. In this relation, our Medical Laboratories have made more than 300 contributions to medical science and public health during the past few years. These are added dividends, not figured in the original planning on a specific project, but which help to make our nation stronger economically and socially.

Some of you may be familiar with the Corps and its objective through the reading of scientific literature, by hearing Corps speakers, or by working on contract projects—or through hearsay.

If it's through the three former, you probably realize that toxic munitions could play a big part in any atomic-age war; for the very destructiveness of nuclear weapons might deter their use, while the toxic weapons do not destroy the physical objects so necessary for a nation's economy. The destruction of factories and machines can prove as costly to the victor as the vanquished in the post-war period because of the vast amount of treasure that must be spent in re-building a defeated nation.

However, if you know of us through "hearsay," you might not have a completely factual conception of the uses of chemical and biological agents.

In your organization's Code of Ethics (section three of Article Eight), there is the statement that the members of the American Institute of Chemical Engineers shall:

" . . . avoid and discourage sensationalism, exaggeration, and unwarranted statements . . . "

This is something that every man, woman, and child should follow, especially when considering the aspects of chemical or biological warfare. Unfortunately, however, there are still many who like to delve into the sensational, the lurid, and the exaggerated—and chemical and biological warfare has been more misunderstood and maligned than any other form of warfare.

The engineer, looking at the situation logically and dispassionately, can do much to help forestall this type of thinking. He can help lead the way in preparing our nation's defenses, materially and mentally, not only against nuclear attack, but also against toxicological attack if it should ever again become necessary to protect our freedom.

The role of the scientist is to think and research the ideas to meet our problems; the role of the engineer is to transform those thoughts into the realm of practicability. It is apparent throughout the world that engineers and scientific research men, working side-by-side, are all-important to the structure of today's civilization.

Progress being made today, just as it was a hundred years ago, greatly reflects the engineer's mind. The type of thinking instilled in a man by engineering training and experience is giving us great industrial, educational, administrative and military leaders. So long as this condition exists, our nation will remain strong and progressive.

USE OF RECORDED KNOWLEDGE

Western Reserve University will be host at a three-day conference on "Practical Utilization of Recorded Knowledge—Present and Future," to be held Jan. 16-18, 1956, on the WRU campus in Cleveland, Ohio.

Emphasis will be on organization and use of printed material in such areas as the sciences, law, patents, military and government information, business, industry and education.

Offering the conference will be Western Reserve's School of Library Science.

INDUSTRIAL PLANT MODELS AID THE CHEMICAL CORPS

By Robert C. Green and Stanley P. Shukis
Chemical Corps Engineering Agency, Army Chemical Center, Maryland

The chemical corps engineering agency, in an attempt to facilitate designing and counteract the rising cost of construction, operation, and maintenance of chemical plants, recently purchased its first chemical plant scale model. This purchase was made in line with the practices of the Chemical Corps Engineering Agency, to utilize today's best engineering tools and methods in Chemical Corps Plant Designs.

Background

Models have been used in other fields (architecture, advertising, and sales) for many years; some modeling firms specializing in building industrial models have been in business since 1939. It has just been recently, though, that the more progressive elements of the chemical industry have begun to make use of them. Slow acceptance of this technique was due primarily to normal caution shown new developments, high cost of models, and delays caused by the time required by model makers. Construction time of models was appreciably shortened and model cost was lowered when standard, ready-made parts which showed important engineering features of the full-scale items while eliminating superfluous, showy detail, were made available.

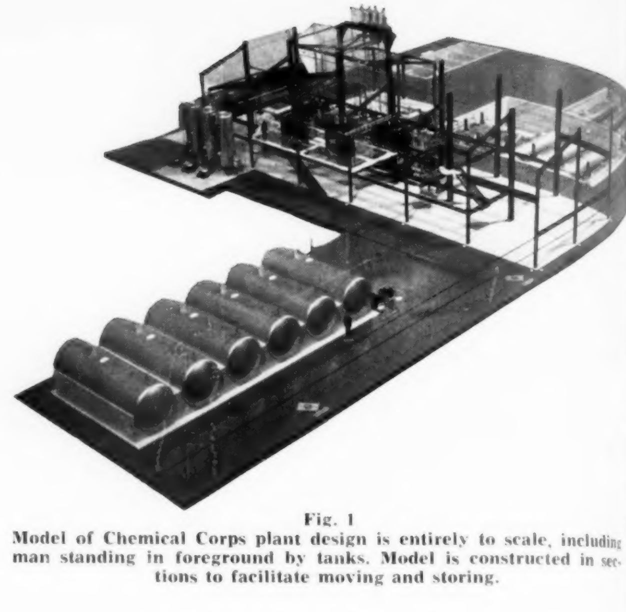


Fig. 1
Model of Chemical Corps plant design is entirely to scale, including man standing in foreground by tanks. Model is constructed in sections to facilitate moving and storing.

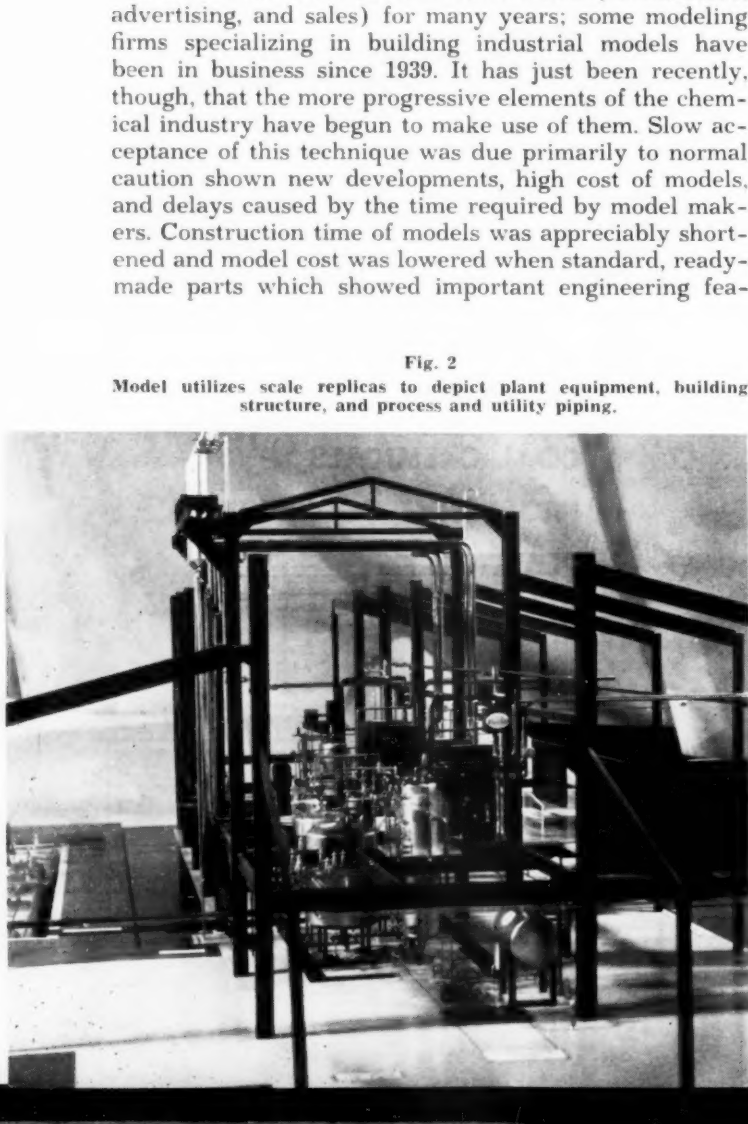


Fig. 2
Model utilizes scale replicas to depict plant equipment, building structure, and process and utility piping.

Type of Models

There are five stages in a design and construction project in which models are useful. Each calls for a different type of model to meet the particular need of that stage. In the latter stages, generally only slight modifications are required from one stage to the next. Many projects, because of design peculiarities, do not warrant all stages of the model development and thus some may be eliminated. The five stages are: 1) *rough layout model*, 2) *equipment location model*, 3) *wire and disk piping model*, 4) *scaled piping or check model*, and 5) *as built model*.

The *rough layout model* is usually to a small scale, utilizing pieces representing the approximate shape of the plant equipment. The designer uses it to locate the items of equipment most advantageously. This model is extremely inexpensive but usually saves considerable money and improves layouts by providing a tool that can be used at a conference. The interested groups involved in any particular project use this model to resolve basic policy and set the pattern for clear-cut action by each group on the balance of the design. From this model sketches could be made to show the equipment location and arrangement. These sketches would be the basis of the second model stage, the *equipment location model*.

The *equipment location model* is made to a somewhat larger scale, usually 1/4 or 3/8 inch to the foot, representing the building structure and equipment in considerable detail. Using the process flowsheet, the piping for the plant would then be installed on this model. This would result in the *wire and disk piping model*.

The *wire and disk piping model* illustrates the piping of the plant by using wire encircled by small disks (which are able to slide along the wire) to denote outside line diameter (including insulation). The flowsheet indicates a line of a certain size connecting one piece of equipment with another. This fixes the location of the ends of the pipe, but not the path which the pipe follows. This path is decided upon by the model maker in conjunction with the design people. The pipes are made as short as possible, with as few bends (more expensive than straight pipe) and fittings as possible. The most expensive pipe which might be either the largest diameter or an expensive alloy type pipe, is installed on the model first. Therefore, any other piping subsequently installed which

might be rerouted to avoid interferences would be the less expensive pipe. By installing pipe in this manner, all interferences have been circumvented as the pipe has actually been installed on the model in miniature. From this model, piping drawings are rapidly made which with a minimum of revision result in the final drawings. The usual repetitive changes and checking which require between 75 and 150 additional hours per drawing are avoided. The finished piping drawings enable the construction people to decide what portions of pipe are to be prefabricated and where field assembly or welding will be necessary.

The next step would be to replace the wire and disk piping with scaled piping. This model would display piping to scale and locate valves and important instruments. This model is known as the *scaled piping* or *check model*, since the piping and equipment layout design can be checked from it.

During construction, any changes made in the design are reflected on the model, resulting finally in an *as built model*. This model represents the plant as it was actually built and is used in training personnel to operate the plant.

Chemical Corps Plant Model

The initial model procured by the Chemical Corps Engineering Agency for use in a plant design is a check model shown in figure 1. This model depicts each of the various pieces of equipment. It illustrates the structural members housing the plant as well as the plant equipment consisting of pumps, tanks and vessels. (Fig. 2) Included also are the process piping which connects the equipment and the utility piping which supplies steam and water and removes waste. Valves are located, important instruments are shown, and small cardboard arrows (Fig. 3) indicating name of fluid flowing, the direction of flow, and conditions of the fluid are attached to the piping. Different types of valves are marked by different colored handles. For instance, the automatically controlled valves are colored red, remote operated valves colored black, and hand operated valves colored silver. Each piece of equipment is labeled with its item identification number (Fig. 4) for easy identification. A railroad spur (Fig. 1) which passes through the building is shown together with a pipe trench and ventillation duct by painted lines on the model base. The elevation above sea level of the floors is given and specific plant areas such as the control room are labeled. Portions of the flooring and entire walls and roof have been eliminated to show the interior. Outside the building, tank farms to store raw materials and products, a basin for disposing of wastes, and other important highlights are visible.

Value of a Model

Models utilizing all the development stages usually range in price from 0.3% to 0.6% of the total installed plant cost. The fact that the most successful industrial firms are willing to pay this price should be sufficient proof that this is no mere fancy toy as it may appear at first.

Industry has found that the cost of a model can be returned many times over, if the model is properly utilized. Some of the major advantages in using models are: 1) a plant of superior design, 2) lower cost for designing, constructing and maintaining the plant, 3) an aid in training operating personnel and 4) a more easily evaluated plant design.

The model aids in effecting superior design by enabling the designer to make full use of human engineering principles in locating the equipment and piping most effectively and in efficiently utilizing the required space. In

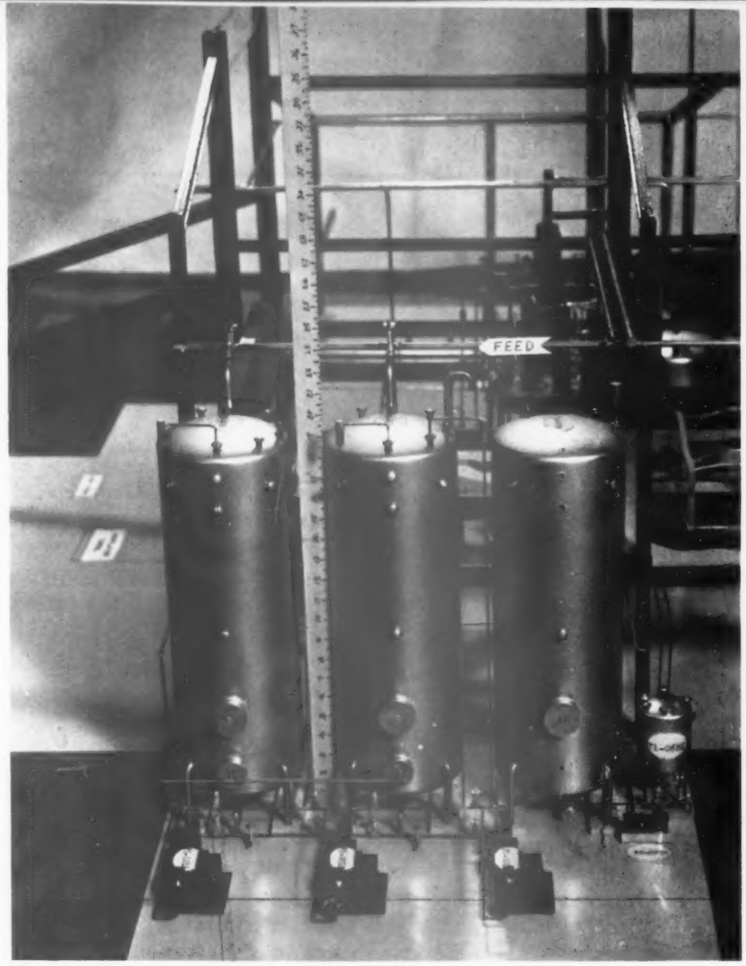


Fig. 3
Model shows valves located on piping. Flow direction and description of fluid are indicated by cardboard arrows. Using calibrated scale, equipment dimensions can be read directly from model.

the planning stages, the equipment location is rarely definite. The designer can relocate the scale models of the equipment very easily, making sure that aisles and working spaces around the equipment are of proper size for efficient and safe working conditions. He can easily note pipe congestion or interferences between a pipe and a structural member of the building. He can avoid inaccessible valves and instruments. He can make certain that lighting fixtures are not hidden behind beams or columns where they will be ineffectual. He can aid in the planning of future maintenance by locating equipment in easily accessible places. If in the later stages of the design it is decided to substitute new equipment, he can easily see possible interferences.

The use of a model cuts the cost of designing and constructing the plant by saving time and materials. The piping of a plant is cheaper since the model maker, in piping the plant, can easily see the shortest route, utilizing the least number of expensive fittings and bends between pieces of equipment. Piping drawings, while not being entirely eliminated, are greatly simplified and more quickly prepared. The need for reworking drawings as piping interferences are noted is eliminated, since all interferences have been removed before the drafting stage is begun. Instead of using two lines to represent the diameter of a pipe, when checking for interferences, only one line is necessary to show the path of the pipe. The model also simplifies checking the piping drawings.

Large savings are also obtained in the construction phase. It is estimated that contractors bid 10 to 15 percent lower on construction jobs where they can study a model to understand the work involved without having to re-

(Continued on page 22)

THE ISSUE OF GAS WARFARE

By Dr. Leo P. Brophy
Acting Chief, Historical Office,
Office of the Chief Chemical Officer
Department of the Army

FOREWORD

This article is an excerpt from a chapter of a forthcoming volume on the history of the Chemical Corps in World War II by Dr. Leo P. Brophy and Col. George J. B. Fisher, USA (Ret.). This volume, the first of three on the Chemical Corps in World War II, has been approved for publication by the Chief of Military History, Department of the Army. These volumes are part of the series, U. S. ARMY IN WORLD WAR II.

Dr. Leo P. Brophy is responsible for this chapter.

Leo P. Brophy was born in McAdoo, Pa., on January 6, 1903. He received an A.B. degree from Franklin and Marshall College in 1927, an M.A. in history from Fordham in 1934, and a Ph.D. in history from Fordham in 1940. After teaching history and sociology at Fordham and Seton Hall Universities he joined the Historical Office of the Chemical Corps in 1945. He is now acting chief of that office.

Announcement of the creation of the Chemical Warfare Service in 1920 as a branch of the permanent military establishment presumably settled an issue that had been discussed heatedly and at length. Actually, debate over functions of the CWS was to continue for many years. This perennial controversy had its roots in two spheres. One was the United States policy on gas warfare. The other was the War Department's reaction to gas warfare.

For centuries the use of poisons for military purposes has been generally disavowed by civilized nations.[1] But not until the end of the nineteenth century, when the science of chemistry had advanced to a point where the use of toxics in warfare was being seriously considered, was the question raised as to whether toxics loaded into ammunition should be considered poisonous. Discussion of this point was listed on the agenda of an international conference, which, upon the initiative of the Russians, met at The Hague during the summer of 1899.

The agreement offered for consideration at the meeting would bind the contracting powers to agree "to abstain from the use of projectiles, the sole object of which is the diffusion of asphyxiating or deleterious gases."[2] In instructions to the American delegates before they left to attend this conference, Secretary of State John Hay had stated, "The expediency of restraining the inventive genius of our people in the direction of devising means of defense is by no means clear . . . the delegates are therefore enjoined not to give the weight of their influence to the promotion of projects the realization of which is so uncertain."[3] The United States therefore did not subscribe to the antigas agreement, although a number of nations did.[4]

The refusal of the United States to participate at this time in formal measures to outlaw the employment of toxic chemicals was not based on lack of American sympathy with the purposes of the proposal. It was the result, rather, of unwillingness to act in the uncertain light of what was then only a nebulous possibility. Moreover, since the Hague antigas declaration specifically outlawed only projectiles, its phrasing could be interpreted as a stimulus to the devising of other means of dissemination. Because of this loophole the German attack at Ypres in April 1915, when chlorine gas was released from charged cylinders, did not violate the letter of the Hague declaration.[5]

The Hague antigas declaration was a casualty of the Ypres attack even though it did not specifically apply. Both the Central and Allied powers developed and used toxics which were disseminated by a number of means, including projectiles, throughout the war. The spirit of the Hague declaration lived, however, to become a part of the effective Allied antigas propaganda weapon which stimulated widespread public indignation against the "barbaric" and "inhuman" employment of toxics by the enemy.[5a]

After the war there was wide reaction against the future employment of war gases. The peace treaties signed by the Central Powers all contained the clause "the use of axphyxiating, poisonous or other gases and all analogous liquids, materials or devices being prohibited, their manufacture and importation are strictly forbidden."[6]

1 Hugo Grotius, **De Jure Belli ac Pacis**, 1625, trans. Francis W. Kelsey, THE CLASSICS OF INTERNATIONAL LAW (Oxford: Clarendon Press, 1925), III, 651-52.

2 "The Hague Declaration (IV, 2) of 1899 Concerning Asphyxiating Gases," Pamphlet No. 8, **Carnegie Endowment for International Peace, Division of International Law** (Washington: The Endowment, 1915)

3 Ltr, Secretary of State to Hon. Andrew D. White **et al.**, 18 Apr 1899, in Special Missions, Department of State, Vol. IV, October 15, 1886-June 20, 1906. National Archives.

4 The Hague antigas agreement was signed and ratified by twenty-five powers.

5 Cyrus Bernstein, "The Law of Chemical Warfare," **The George Washington Law Review**, X (June 1942), 889-915. Portions of this article were reproduced in Chemical Warfare Bulletin, XXVIII (Oct 1952) 174-86.

5a For details on antigas propaganda see (1) James M. Read, **Atrocity Propaganda 1914-1919** (New Haven: Yale Univ. Press, 1941, p. 6 and pp. 95-99; and (2) H. C. Peterson, **Propaganda for War** (Norman, Okla.: Univ. of Oklahoma Press, 1939), p. 63.

6 G. H. Hackworth, **Digest of International Law** (Washington: Dept of State, 1943), p. 269.

This wording presumably applied only to the defeated states. Subsequent agreements between the Allies and other powers were needed to insure universal prohibition of gas warfare.

The policy of the United States in the matter of toxic chemicals was clearly expressed at the Conference on the Limitation of Armament which met in Washington in 1921. This question was one considered earlier by a subcommittee on land warfare of which General of the Armies John J. Pershing was chairman. Pershing's group recommended that "chemical warfare should be abolished among nations as abhorrent to civilization."[7] Another report submitted at this time by the General Board of the Navy stated that it was believed "to be sound policy to prohibit gas warfare in every form and against every objective."[8] Both of these reports were considered by, and no doubt strongly influenced, the U. S. delegation at the Washington conference in formulating its proposal to prohibit the use of poison gas in war.

Colonel George J. B. Fisher was born in Camden, N. J., on 27 June 1893. After attending Drexel Institute he served with the National Guard on the Mexican border and entered the National Army in August 1917. He was commissioned in the Coast Artillery, Regular Army, in 1920; transferred to the Chem. Corps in 1929; retired in 1947. Col. Fisher is now a consultant of the Historical Office.

The United States proposal was incorporated as Article 5 in the Washington Conference treaty covering the Use of Submarines and Noxious Gases in War. This article, after stating that the employment of toxic war gases had been condemned by world opinion and prohibited in numerous existing treaties, announced that the contracting parties, "to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, declare their assent to such prohibition, agree to be bound thereby as between themselves and invite all other civilized nations to adhere thereto."[9] The treaty was never ratified by France, one of the principal signatories, and therefore never came into effect.[10] It remains the only antigas convention the ratification of which the United States Senate has ever approved.

The proposition of outlawing gas warfare was revived at a conference held in 1925 at Geneva to consider regulating the international traffic in arms. Here the United States delegation was instrumental in introducing and obtaining general agreement to what has been called the Geneva Gas Protocol. This instrument, after reiterating a general condemnation of the use of toxic agents in war, declared that the contracting parties had agreed to prohibit the use of such materials in the future and had further agreed "to extend this prohibition to the use of bacteriological methods of warfare and . . . to be bound as between themselves according to the terms of this declaration."[11] Although the United States delegation signed this protocol, the U. S. Senate refused assent to its ratification.

A cross-section of opinion in the United States as to the military usefulness of gas warfare and the prospects of preventing its employment by international agreement were brought out in Senate debates on the ratification of the Geneva Gas Protocol.[12] Some leading military figures were quoted as expressing agreement with eliminating gas as a weapon of war. Considerable opposition to ratification came from civilian groups, especially veterans' organizations. Despite the fact that it was not approved by the Senate, the protocol was supported in principle by the executive departments of the U. S. Government. By the time World War II began, the Geneva Gas Protocol was adhered to by forty-two nations and was the most generally accepted expression of international opinion relating to the use of toxic agents in war.

The influence of national policy and of international agreements limiting employment of toxic agents in war was of obvious concern to the War Department. This matter was clarified in a letter written by Secretary of State Frank B. Kellogg on 7 December 1926, which supported continued military preparations in this field:

> **All governments recognize that it is incumbent upon them to be fully prepared as regards to chemical warfare, and especially regards defense against it, irrespective of any partial or general international agreements looking to the prohibition of the actual use of such warfare. I have never seen any proposal seriously advanced by any government to provide that national preparation for the use of and for defense against chemical warfare, if such warfare should be used by an enemy contrary to treaty agreements, should be abolished or curtailed in the slightest.[13]**

In agreement with this statement was the Joint Army-Navy policy on chemical warfare which in 1934 was framed in these words:

> **To make all necessary preparations for the use of chemical warfare from the outbreak of war. The use of chemical warfare, including the use of toxic agents, from the inception of hostilities, is authorized, subject to such restrictions or prohibitions as may be contained in any duly ratified international convention or conventions, which at that time may be binding upon the United States and the enemy's state or states.[14]**

All Presidents whose administrations spanned the interwar years sought the elimination of gas as a military weapon. Herbert Hoover and Franklin D. Roosevelt, who saw eye to eye on this issue, were particularly outspoken. President Hoover steadily urged elimination before the disarmament deliberations that took place while he was in office. By the time of President Roosevelt's inaugura-

(Continued on page 35)

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[7] Quoted by Sen. William E. Borah (R., Idaho) in **Congressional Record,** Vol. 68, Pt. I, p. 140.

[8] **Ibid.** p. 143.

[9] Department of State, **Papers Relating to the Foreign Relations of the United States, 1922** (Washington: Dept of State, 1938) I, 276

[10] The other signatories were the British Empire, France, Italy, and Japan. The reason for the failure of France to sign this treaty was the fact that it also outlawed submarine warfare, to which the French were unwilling to agree.

[11] Department of State, **Papers Relating to the Foreign Relations of the United States, 1925** (Washington: Dept of State, 1940) I, 89-90.

[12] **Congressional Record,** Vol. 68, Pt. I, pp. 141-54, 226-29, 363-68.

[13] Cited in **Congressional Record,** Vol. 68, Pt. I, p. 366.

[14] Ltr, The Joint Planning Committee to the Joint Board, 17 Oct 34, sub: Use of Chemical Agents. Joint Bd Doc No. 325, Serial 542.

PLANT MODELS

(Continued from page 19)

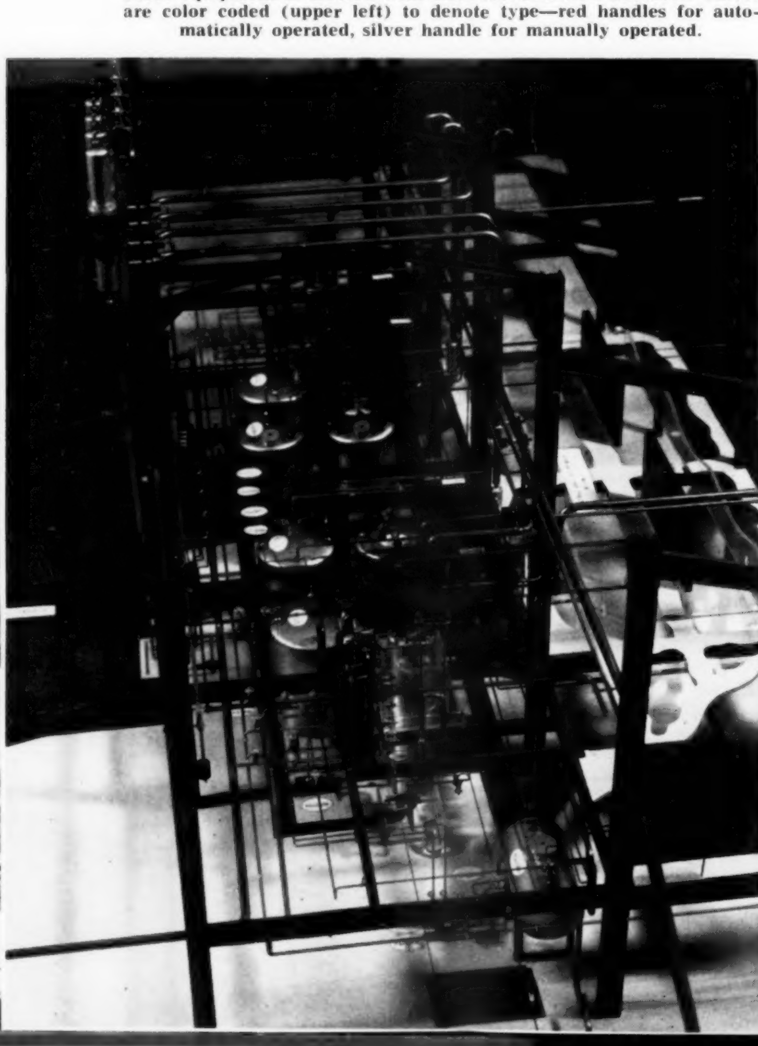
view a mass of blueprints. This increase is usually added as a protective measure in the event the contractor has some doubt concerning the exact nature of the work he is to perform. Here alone, the cost of the model may be saved many times over. It is possible to schedule work more easily, so that cooperation between crafts, such as steamfitters, steel workers, electricians, etc., is improved. For instance, it may be possible for the same scaffolding to be utilized by more than one group, rather than each erecting his own. The constructor can more easily schedule the order of installing certain piping and equipment which in many cases is critical. Construction work is more rapid because fewer design errors slip through previous checking when a model is used.

The model as a training aid, to teach operating personnel to run the plant, is invaluable. Such training can begin even before the plant is completed, thus assuring a faster start-up. It is far easier for operators to visualize the flow of material on the model than on blueprints, and even easier than in the plant itself. From the model, one can get an overall view of the relationship between a certain line or valve and an entire process, rather than merely observing a maze of pipe stretching as far as one can see, as it is in the actual plant. It is faster, simpler and more instructive to trace a pipe path on the model than follow it from floor to floor in a large chemical plant.

The model also has an intangible value in enabling the

Fig. 4

Plant equipment is labeled with item identification numbers. Valves are color coded (upper left) to denote type—red handles for automatically operated, silver handle for manually operated.



design group to rapidly familiarize persons with the plant even though they have had no previous contact with its design. At meetings where the plant is discussed and evaluated, the model can be effectively used to point out various design features. It is considerably faster and far easier to understand complicated aspects of the design if the model is used as a supplement to blueprints. Management can often better evaluate the measure for which they are being asked to invest large sums of money when a model is available.

Model Advantages to Chemical Corps

The advantages of utilizing a model in plant design have been proven by industrial use. Though the Chemical Corps generally obtains these same advantages, certain aspects of its operation peculiar to the Engineering Agency make some even more important. Most of the Engineering Agency plant designs and nearly all construction work as a result of these designs are contracted and sub-contracted to private industry. Therefore, it is very desirable to have a method of rapidly checking equipment layout and process piping design. Use of the model satisfies this demand. It also eliminates many drawings, the checking of which is a prodigious task.

The saving in construction, by virtue of lower bids, is also very important, especially when work is sub-contracted and any additional costs pyramid from sub-contractor to contractor to Chemical Corps.

The primary advantage, however, is in a more rapid job of design and construction of the plant when a model is used. A design aid such as the plant scale model, resulting in a superior designed plant, finished in a shorter period of time, and at a decrease in cost, is indeed an obvious "must" for any member of our National Security Establishment.

Problems in Model Use

Invariably new industrial developments suffer at first from some drawbacks. But, if these drawbacks are recognized and considered, especially in the planning of the model, they can be overcome.

The most important thing to remember is that designers, draftsmen, constructors, and operators all must learn to utilize the model if it is to prove a sound investment. One of the biggest reasons against using the model would be if it has been found to be in error. Therefore it is mandatory that any design changes be reflected on the model as rapidly as possible. Along with this, the model must be thoroughly and completely checked with the flow diagrams and other drawings to insure the model being correct.

Since the model gives the designer an ideal opportunity to keep improving upon the design, more than the usual drawing method, the project leader must be prepared to fix the design at some particular point allowing no more minor changes to be made. Otherwise, a perfectionist design will hold up construction and offset much of the model value.

A frequent problem arises when more than one group requires the model at the same time. Some companies

have tried building more than one model, but in general this has not been satisfactory as the expense is increased and the difficulty of keeping both models up to date has not been overcome successfully. Ultimately the use of additional models resolves itself into a matter of judiciously weighing the need for the particular case.

Model planning must begin early, so that work will not proceed past a point where proper model utilization is impossible. Even if all the stages are not to be used, this decision should be made early so that the model types which are built are utilized fully.

At the Chemical Corps Engineering Agency each proposed plant design is carefully studied to determine whether or not the model should be included as an integral part. Some projects which are small, or relatively simple in process design and required piping, do not warrant all stages of a model, or even any model at all. This decision usually is made by the project or group leader and is arrived at in the early planning stages.

Summary

The primary advantages which can be expected from the incorporation of a model in a plant design are: 1) a superior designed plant with fewer safety hazards, locating all valves, instruments and pieces of plant equipment properly, 2) a plant designed for easy maintenance and operation, 3) a less expensive designed and constructed plant, built in a shorter period of time, 4) a more rapid plant start-up by requiring a shorter training period for operating personnel and necessitating fewer start-up design changes because of improperly placed or omitted items of equipment, 5) a plant which can more easily be evaluated by management since they see what they are buying.

When buying a model certain problems must be considered. They are:

1) The model *must be utilized* if it is to be of value.

2) The model *will not be utilized* if it is found to be in error.

Consequently the model must be thoroughly checked and constantly brought up to date.

3) An over-zealous designer must not be allowed to hold up the construction phases by making numerous small changes after the design is completed.

4) The group director must promote cooperation between groups requiring use of the model, in order that it is utilized most efficiently.

5) Planning for a model must begin early and evaluations made to determine which phases of the model are warranted.

The scale model is a new and important tool available to the chemical plant designer. Tremendous savings in time and money can be made if he utilizes it efficiently. Accurate thinking and a careful consideration of all problems involved in model work are of utmost importance in discovering that the scale model has a practical future in chemical plant designing.

PLANT MODELS

(Continued from page 19)

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The model as a training aid, to teach operating personnel to run the plant, is invaluable. Such training can begin even before the plant is completed, thus assuring a faster start-up. It is far easier for operators to visualize the flow of material on the model than on blueprints, and even easier than in the plant itself. From the model, one can get an overall view of the relationship between a certain line or valve and an entire process, rather than merely observing a maze of pipe stretching as far as one can see, as it is in the actual plant. It is faster, simpler and more instructive to trace a pipe path on the model than follow it from floor to floor in a large chemical plant.

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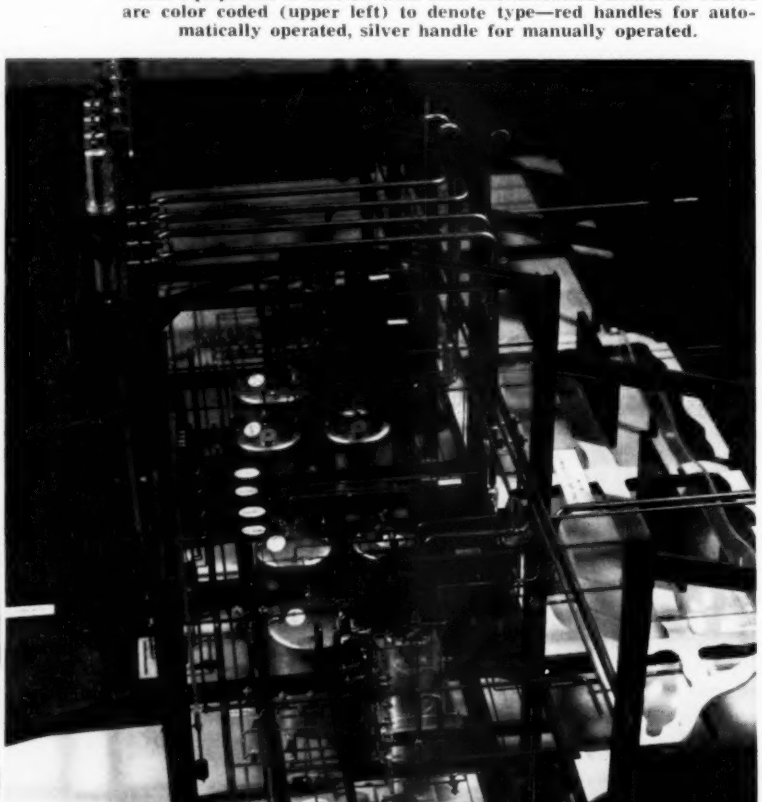

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The saving in construction, by virtue of lower bids, is also very important, especially when work is sub-contracted and any additional costs pyramid from sub-contractor to contractor to Chemical Corps.

The primary advantage, however, is in a more rapid job of design and construction of the plant when a model is used. A design aid such as the plant scale model, resulting in a superior designed plant, finished in a shorter period of time, and at a decrease in cost, is indeed an obvious "must" for any member of our National Security Establishment.

Problems in Model Use

Invariably new industrial developments suffer at first from some drawbacks. But, if these drawbacks are recognized and considered, especially in the planning of the model, they can be overcome.

The most important thing to remember is that designers, draftsmen, constructors, and operators all must learn to utilize the model if it is to prove a sound investment. One of the biggest reasons against using the model would be if it has been found to be in error. Therefore it is mandatory that any design changes be reflected on the model as rapidly as possible. Along with this, the model must be thoroughly and completely checked with the flow diagrams and other drawings to insure the model being correct.

Since the model gives the designer an ideal opportunity to keep improving upon the design, more than the usual drawing method, the project leader must be prepared to fix the design at some particular point allowing no more minor changes to be made. Otherwise, a perfectionist design will hold up construction and offset much of the model value.

A frequent problem arises when more than one group requires the model at the same time. Some companies

have tried building more than one model, but in general this has not been satisfactory as the expense is increased and the difficulty of keeping both models up to date has not been overcome successfully. Ultimately the use of additional models resolves itself into a matter of judiciously weighing the need for the particular case.

Model planning must begin early, so that work will not proceed past a point where proper model utilization is impossible. Even if all the stages are not to be used, this decision should be made early so that the model types which are built are utilized fully.

At the Chemical Corps Engineering Agency each proposed plant design is carefully studied to determine whether or not the model should be included as an integral part. Some projects which are small, or relatively simple in process design and required piping, do not warrant all stages of a model, or even any model at all. This decision usually is made by the project or group leader and is arrived at in the early planning stages.

Summary

The primary advantages which can be expected from the incorporation of a model in a plant design are: 1) a superior designed plant with fewer safety hazards, locating all valves, instruments and pieces of plant equipment properly, 2) a plant designed for easy maintenance and operation, 3) a less expensive designed and constructed plant, built in a shorter period of time, 4) a more rapid plant start-up by requiring a shorter training period for operating personnel and necessitating fewer start-up design changes because of improperly placed or omitted items of equipment, 5) a plant which can more easily be evaluated by management since they see what they are buying.

When buying a model certain problems must be considered. They are:

1) The model *must be utilized* if it is to be of value.

2) The model *will not be utilized* if it is found to be in error.

Consequently the model must be thoroughly checked and constantly brought up to date.

3) An over-zealous designer must not be allowed to hold up the construction phases by making numerous small changes after the design is completed.

4) The group director must promote cooperation between groups requiring use of the model, in order that it is utilized most efficiently.

5) Planning for a model must begin early and evaluations made to determine which phases of the model are warranted.

The scale model is a new and important tool available to the chemical plant designer. Tremendous savings in time and money can be made if he utilizes it efficiently. Accurate thinking and a careful consideration of all problems involved in model work are of utmost importance in discovering that the scale model has a practical future in chemical plant designing.

CREATIVITY IN SCIENCE

By Dr. Charles Allen Thomas

President, Monsanto Chemical Company

The Eighth Annual Arthur Dehon Little Memorial Lecture at the Massachusetts Institute of Technology.

I appreciate the honor of being asked to deliver the Arthur Dehon Little Memorial Lecture. The topic . . . creativity . . . on which I shall offer my opinions is imponderable, an unweighable "something"—a phenomenon peculiar to man of all the animals, and more peculiar to certain kinds of men. My purpose will be to examine this phenomenon with you and then to evaluate certain factors in our social order that I believe affect the creativity of the individual. Because creative urges originate in the mind, this analysis will, of necessity, be subjective—with the data and the postulates based on intensely personal phenomena. It is my hope, however, that the analysis will fulfill the purpose of these lectures: to stimulate your interest and your discussion of this important topic.

Like many people, I have from time to time reflected on the mysterious nature of creative thinking and have noted many references including pointed aphorisms, poetic reflections, and philosophic dissertations on this subject throughout literary history.

But paradoxically, in America, where society has benefited most from creative thinking in the physical sciences, we have not given much thought to the actual process of creativity until quite recently. Prior to 1940 I can recall very little in print or discourse concerning the subject. But for the past five years, I have observed both among my colleagues and among our writers a mounting concern with this whole problem of creative thinking, inventiveness, and the importance of new concepts and ideas. This intense interest in American creativity is apparent not only among businessmen but among the scientists themselves. The hue and cry that the art and literary critics have always raised for originality and new horizons in the arts appears now to be echoing throughout industry and the universities.

Perhaps never in our history has such a premium been put upon creative thinking—in both pure and applied science. Our highly competitive economy makes industrial progress essential. Each industry strives to find ways to make its current products and methods of production obsolete. Clever, creative thinkers in the applied sciences are crowding on the heels of pure researchers—actually as well as figuratively—snapping up the morsels of their discoveries, applying them in ingenious ways to contribute to our material welfare. It is estimated that American industry in 1954 spent over 1.5 billion on research. The Federal Government in its military establishments—in the hundreds of projects primarily linked with national defense and secondarily with public health, conservation, and agriculture—employs approximately 50 percent of our scientific manpower. Our society has become conscious of the value of creative thinking in science in much the same manner as a vigorous man with a back-breaking work schedule suddenly becomes conscious of his health. He is shocked at his utter dependence upon something he had always taken for granted.

Creative thinking in science is one of mankind's most vital resources. We depend upon it for our material welfare; we depend on it for our industrial advancement; and, indeed, we depend on it for our very existence in these days of international tension. In the fields of sociology, economics, ethics, and psychology, we must de-

CHARLES ALLEN THOMAS

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Dr. Thomas was a pioneer in the development of tetraethyl lead, widely used in motor fuels; as research director, vice-president and president of the Monsanto Chemical Company, he has been responsible for the Company's technical direction and research since 1936, and he is also distinguished for his work in the public service. He was project director for the final purification and metallury of plutonium at Oak Ridge during World War II and he is one of five co-authors of the Atcheson-Lilienthal Report on the international control of atomic energy.

Dr. Thomas was born near Lexington, Ky., in 1900 and attended Transylvania College before going to the Massachusetts Institute of Technology where he received the Master of Science Degree in chemical engineering. He has taken an active part in moves to improve scientific education at secondary schools and colleges and has worked also for the promotion of effective use of scientific personnel in the military services.

The Arthur Dehon Little Memorial Lectureship at the Massachusetts Institute of Technology was established in 1944 with funds donated by the engineering firm of Arthur D. Little, Inc., in memory of its founder. The lecture program was inaugurated in 1946. Its purpose is the promotion of interest in and the stimulation of discussion of the social implications inherent in the development of science.

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pend upon creative thinking to assimilate the advancements of science into a culture that will help the individual live in peace and happiness; that will coordinate the various disciplines into a harmonious relationship which will foster the advance of civilization. And this vital resource—even as it applies to science—is a mercurial and ephemeral disposition of the mind—virtually impossible to measure quantitatively. The best that we can do is to isolate a specific period of history and count the evolution of new, basic concepts and the application of new technological advances which have occurred within that time span.

Such a procedure, however, is not a measurement of individual creativity . . . the point from which we should begin. When we speak of creative thinking, we are speaking of an intensely personal phenomenon—a particular kind of activity of the human mind. To discover its anatomy, we must start in the realm of psychology. And when we assess the factors that foster or hinder its exercise, we are compelled to examine the factors that affect the mind-body relationship, the factors that affect the personality, and the factors that affect the social interdependencies which are bound up so closely with personal well-being and adjustments. I propose that we start with a definition, a definition as tangible as possible of something that we have already agreed is intangible.

Of what are we speaking when we discuss creative thinking?

We can agree at once that creative thinking is not a simple concept; when one considers the difficulty of actually defining "matter," how much more magnified is the problem of defining "creativity."

FOR OUR DEFINITION, therefore, we must consult authorities, examine the phenomenon itself, and look intimately into our consciousness. With these composite data we can hope to arrive at a definition of creative thinking that will allow us to evaluate the factors in modern society which have a bearing upon its invigoration or its weakening.

The kind of thinking we name and value as truly creative is the play of the mind on concepts divorced from our personal complacencies, triumphs, and humiliations; its judgments are concerned with a higher order of decisions than those required for everyday acts; its logic is far purer and more objective than the specious arguments we formulate to defend our cherished beliefs and prejudices. If we were to stop with these facets of the phenomenon itself, we might be led to believe that "creative thinking" is a working of the mind distinguished primarily by a facility for impersonalness or detachment. And while this certainly is true of creative thinking in its exercise, its stimulation I believe to be intensely personal, tightly bound up with our volitional and emotional nature. Thus we may say that creative thinking in its *performance* is completely impersonal; in its motivation it is intensely personal.

Some attributes of the creative mind are accepted almost as axioms: curiosity, imagination, enthusiasm, and a high level of mental energy. But in our more searching analysis we come to that delicate, difficult question: What factors cause these qualities of curiosity, imagination, and energy to be used creatively? It is here that we have to look inward, examine personal evidence, and make an honest judgment.

I will make it boldly.

It would appear to me that the stimuli that impel a qualified mind to perform creative work are closely aligned with the ego, the consciousness of self; they are identifiable with an urgent need for self-fulfillment and self-expression. On a lower plane, they coincide with a heightened sensibility of social approval, and still lower—to a point of being questionable— are associated with the understandable and common desire to better one's self in a purely material way. Usually they are a mixture of two or all three.

May I repeat some of the points I have made to make certain that in dealing with these nebulous concepts in the slippery medium of discourse our basic premises or relationships are not lost?

We have defined creativity as a composite of curiosity, imagination, enthusiasm, and energy engaged in the pursuit of matters that in themselves have no close or direct personal significance. We have stated that based on subjective judgment, the motivating factors that influence men to dedicate these attributes to a life of creativity are, in descending order of importance: the human ego's appetite for distinctive definition; the individual's personal urge to seek self-fulfillment in a unique manner of his own choosing. We have asserted that another incentive is rooted in a person's heightened consciousness of social approval. And finally, we have suggested that there may be a third force, or stimulus to creativity, much more questionable than the others—the desire to attain material success.

I suspect, although I have no proof, that creative activity of the human mind and the causation of stimuli are identical, whether the creativity expresses itself in art, music, literature, philosophy, or natural science. Some of the same factors, therefore, that affect creativity in the sciences also influence the creativity of people in other callings.

The premises in our definition of creativity and in our analysis of the causative or motivating factors have numerous authorities. Paul Valery puts it bluntly: ". . . there are only three motives by which an artist is impelled to work—either for money, fame, or for art (itself)." Jonathan Swift said: "Violent zeal for truth has a hundred-to-one odds to be petulancy, ambition, or pride." In these two short, pithy sentences are contained our elements of "ego," "personal fulfillment," "social approval," and "profit."

Disraeli said: "Every production of genius must be a production of enthusiasm"—making clear that the act of creative thinking requires energy. We need only recall Galileo's timing the interval of the swinging church lamps by countng his pulse and Newton's dropping apple to substantiate the validity of including "curiosity" in our definition. We can document "imagination" if need be, by recalling the many fabulous developments resulting from Faraday's original discovery—born of curiosity and a simple experiment—which showed that a current is produced in a copper disc moved in a magnetic field.

Our aim, however, is not to provide an exhaustive analysis of creative thinking and its motivations. It is only necessary for our purpose to separate the "act" from its "causation" and to break down that causation into logical components. Once that is done, we can examine these various elements which motivate creative thinking in the light of the world we live in and relate them to our times, which we can call an "Age of Pragmatism." Pragmatism—in the frame of reference for our examination—will be taken to mean pragmatism in its narrowest sense: value predicated upon usefulness or practicality.

WITH ACKNOWLEDGED IMMODESTY I must now indulge in some personal experience, because by looking inward I can thus give my reasoning, the test of personal experience.

In my lifetime I have worn three hats. I have been a research chemist, a director of research, and an industrial executive. I have been fortunate in that I have *participated* in creative work, *have observed and directed* teams doing creative work in groups, and I have in most recent years been in a position both to appreciate its accomplishments and to study the conditions surrounding it. As a result of these experiences and in the light of what we have defined as motivations for creativity, permit me to offer some opinions regarding certain conditions, relationships, attitudes, and forms of organization in our present society that appear to thwart or to foster creative thinking in science. I shall not attempt, however, to evaluate these positive and negative factors in their final effect. Perhaps this can never be done—since individuals vary in their degree of response to factors in their environment. We must remember, too, that the creative thinker is not only affected by the factors of today; he has been affected by his early environment and by the events and changes he personally has experienced over the past quarter-century. Let us examine, first, the profit motive and material security as it relates to creativity in science.

Although differences exist between the universities, the government laboratories, and private industry, technically trained people are among the highest paid salaried groups in our society. Certainly, in terms of economic security, the qualified researcher has had little to worry about as far as material welfare is concerned. His services have been in such demand that he is sought after by individual firms in a variety of industries.

In industry and government we have institutionalized creativity. It is a permanent need—as essential as raw materials to industry, as acutely needed as votes to a democratic government, as vital as endowments to private universities. Creative scientists have not gone begging for at least fifteen years, and our best forecasts indicate the demand for their services will continue to grow.

Has this helped or hindered? If you agree that material gain is one of the motives for "creativity," by supplying this have we removed one of the stimulants?

My conviction is that personal security has helped and will continue to help the scientist in his pursuit of truths that we agree are in themselves divorced from his own personal necessity.

Picture five men on a life raft, where nothing short of a miracle of ingenuity is required for survival. Four may give up both hope and effort and become suicidal; one, by clear creative thinking, devises a means of survival that saves them all. There have been examples of this. This type of creativity has been capsuled in the aphorism: necessity is the mother of invention.

I believe, however, that this is a different kind of creativity—its accomplishments are of an entirely different order from the mental activity that seeks to find the hormones that regulate cell metabolism or works year after year to determine the molecular mechanics of polymerization or the phenomena of photosynthesis.

Is man most "creative" under the strong influence of a base emotion such as hate or fear . . . or bedeviled by a feeling of insecurity? Besides the personal judgment I have made, many authorities say "no." W. H. Auden, for example, has said: "Man is an animal, and until his immediate material and economic needs are satisfied he cannot develop further." To be creative, it would appear that the individual must first have his basic needs comfortably supplied. With our scientists, this has been largely accomplished. No great fear of material insecurity need interrupt their intellectual pursuits.

If, going a step above material welfare, we agree that a more probable motivation toward creative work is a heightened consciousness of and a sharper-than-average appetite for social approval, how do we appraise our scientists' position in our social environment?

I believe that today's scientists are among the least understood and the most misunderstood; the least known and the most highly publicized of all professional people. Scientists as human beings are at once remotely intimate and distantly familiar to every man, woman, and adolescent in America. Speaking a language somewhat unintelligible to most men, scientists are a little like relatives who have lived too long abroad—strangers to the members of their own human family. Everyone is glibly familiar with electronics that created television and radar, with chemistry and physics which made rubber and synthetic fibers; and with radioactive matter, producer of the world's biggest bang—all this was work of scientists. But these are not considered achievements of men such as one sees in restaurants and trains; these are regarded as the achievements of remote figures whose work—because it is not understood in proper context—is believed by the rest of the world to have the most frightening possibilities. Have we not heard members of the scientific fraternity complain that "no one understands scientists"? How often have we heard scientists—speaking as socially-conscious human beings—say people seem to resent them, set them apart?

IT APPEARS TO ME that there is a tendency for everyday people to mistrust scientists and, for that matter, all intellectuals. In this age of slang, anyone whose interests are not common, not immediately understandable, is dubbed a "long-hair." Is it much wonder that scientists tend to become clannish and withdrawn, restricting their social life to those engaged in their own particular specialties? Or is it surprising that some throw up a defense mechanism in response to society's suspicions, and become at times either too cynical or too articulate?

Intense specialization may indeed tend to separate the scientist from broad, intimate contact with less dedicated members of his community, but does this have any significant effect on his creative power? We have suggested that a heightened desire for social approval may be one of the motivations for creative work, and we have conjoined this causative factor with the creative worker's personal need to define his personality in terms of a particular type of self-fulfillment. Since the appetite for self-fulfillment unquestionably begets intense specialization, how comfortable are present-day scientists in their specializations?

I suggest that they are somewhat uneasy, and that this scarcely-conscious uneasiness may in time have a stultifying effect on their creative powers. To enlarge on this, I must with repeated apologies again delve into my own life for illustration.

As a young research chemist at a bench, I was steeped in the desire to uncover new concepts in chemistry, to add to the storehouse of the world's knowledge. The world was then clear-cut; it was black and white. My intellectual interests were completely scientific—but narrowed to chemistry, even further focused on organic chemistry, and still further confined to aliphatic reactions. My reading was avid but restricted to this field. I recall with chagrin the earth-changing discoveries made in physics and biology during this time in my scientific life, discoveries which I did not assimilate in my thinking. Certainly I took no time to study or understand them. The nature of the atom was being unveiled; enzymes and hormones were asserting their importance; even in chemistry there were most important discoveries being

made not directly connected with my work. I took no note of any of this.

These discoveries were destined to affect chemistry—my own field—profoundly, but only in later years did I feel compelled to go back and study them in an effort to catch up with the broader spectrums of science. My breadth of vision was narrow indeed. I had completed a short tour of duty toward the end of the first World War. It was over, and I was back in my laboratory, still without any interest in current events or international affairs. These things were disdainfully unimportant compared to the interaction of a diolefin with a highly substituted aromatic hydrocarbon in the presence of an acid-forming catalyst.

But at no time in my life was my work, such as it was in my specialized field, more creative or original.

Subjectively speaking, then, I can say categorically that I do not believe intense specialization and confinement of social linkages are *of themselves* stultifying to creative accomplishment. My own narrowed intellectual awareness and tight social frame, however, is now over a quarter of a century, a tragic economic depression, and two wars behind me. The comfortable coat of a specialist at that time was not the garb that, in the ghastly light of instant nuclear energy release, now causes private citizens to look at the wearer and wonder. My happy state of mind was buttressed firmly on the scarcely conscious but unquestioned belief that material progress was synonymous with civilization's progress.

This belief was a logical inference from the pragmatism characteristic of late ninteenth and twentieth century thinking.

Unfortunately, neither science nor human nature is as simple as we might wish it. The scientist suddenly finds himself questioning not the validity of his profession but, in a much larger sense, its goals. The creative researcher is learning that government, social, and economic relationships are not, as he had naively believed, systems of rational order, but are a conflicting, tension-filled balancing of forces—in which the products of his creation can have tremendous consequences. Pragmatism may have disastrous consequences, unless it is fitted into a larger, more human and humane ethical framework.

THE URGE TO CREATIVENESS, motivated by social consciousness, therefore may be suffering subconsciously from the confusion of our times. As firmly as Newton's followers believed nature to be uniform and invariable, scientists believed that human nature was uniform and unvariable: ordered by reason, controlled by intellect. Even Hume generalized freely about immutable human nature, which he equated with the nature of an eighteenth century Englishman. It remained for the psychologists and creative thinkers in other fields to show that man is anything but simple, logical, and ordered by reason. The concept of man's dependable rationality collapsed within the same quarter-century in which Newton's simple concept of matter was proved invalid. Scientists have become acutely conscious that in their "scientific progress" they are creating for the free use of human beings such humanely questionable objects as nuclear weapons and guided missiles—and in less fearsome fields, pills for the mind, antibiotics, hormones, and jet travel. Already these products of the test tube have had an incalculable impact upon our habits, customs, and traditions—disturbing and rearranging those forces in society which our forefathers considered "invariable and uniform." And these revolutionary innovations, wonderful in themselves, are being accepted upon the narrow pragmatic premise: "Are they useful?—Then they are good!"

The philosophies of Pierce, James, Kant, and Dewey have left a deep imprint on our thinking. We have become most arbitrary in our definition of what is original or creative. We have identified creative with "action" and "application." With this pragmatic approach, we have come to believe that all our thoughts and study must have a utilitarian function—that all our ideas must be applied practically. On this basis we have tended to evaluate creativity in science. In doing so, our pragmatism runs counter to both observed and subjective evidence. We have seen again and again how obscure scientific truths of no practical value at the time of their discovery have become keystones of practical applications. Paradoxically, this pragmatic habit of thinking is rampant at a time when the government, the military, and industry are crying for more fundamental research, more discoveries in pure science.

Imagination—creative thinking—thrives best in an atmosphere of freedom. But industry today can only justify pure research to its stockholders on the basis of ultimate practicality, and Government can subsidize pure research with taxpayers' money only if it contributes to national defense. Both industry and government recognize these pragmatic deterrents to the complete freedom of thought which creative scientists require. But until investors and taxpayers understand and appreciate these intangible but profound values in science, the dilemma will remain unsolved.

Within the concept of unrestricted, free thought in science, I like the word "amateur" as we might apply it to the game of creativity. The word is taken from the French verb to love; its literal English derivation means to have such a marked fondness for a particular endeavor that one cultivates it eagerly without pursuing it professionally. Many of the notable discoveries in science have been made by amateurs: Newton's work was done as a hobby; professionally he was a government employee. Einstein worked in the Swiss patent office, and mathematics was his hobby.

In every mind there must be a very personal room set aside for "playing with ideas." It should be a place of joy and refreshment where the imagination can roam freely up and down any avenue of thought that strikes the fancy, a place one can return to with an adolescent's enthusiasm untethered by convention or autocratic restraint. When the going is roughest, it is most difficult to

slip away to this room; but that is when creative people have the greatest need for this retreat. It is within this chamber of the mind that creativity and fresh thoughts flourish best.

We have given a pragmatic tinge to our employment of scientists and to our reception of their contributions. Such an attitude, it seems to me, needs to be re-examined because it frustrates the individual in his quest for self-fulfillment by restricting the free play of his creative faculties and energies within the tight boundaries of practicality. To pure scientists who yearn to be true scholars, this atmosphere of pragmatism is disturbing. They sense unseen strings attached to them; they feel an obligation to do something "useful." As a result, even if they uncover new knowledge, they have come to regard their work as a failure unless it can be applied for the benefit of mankind. But who is to say that they have failed? Can we judge in this era of confusion, international tension, and ethics-by-expediency?

THE SCIENTISTS of the late eighteenth, the nineteenth, and the early twentieth centuries embarked upon the great adventure of science with an overriding faith that knowledge of physical and biological laws was the cure for all of mankind's ills. The Age of Enlightment was built on this confident belief; a triumph over nature was a triumph over misery, evil, and fear. This was an ideal to which men could dedicate their lives, and many creative thinkers down to modern times have entered the disciplines with this thought before them.

In the face of the last two decades of fearful events and mounting tensions, it has become apparent to all thinking individuals that knowledge of natural laws and cleverness in their employment is not enough. The ideal has begun to shrivel at the edges. Its dissolution can create a poisonous atmosphere for the creative scientist who, we have suggested, possesses a high degree of social consciousness.

Our next point to consider is the question of the scientist's self-fulfillment in our present cultural order. I mentioned earlier, in passing, that our pragmatic evaluation of scientific achievement creates a strain which is felt by the scientist in his social linkages. A more acute frustration may be present in our current trend toward collectivism, unless delicately managed.

In applied science and in industry, a great deal of scientific exploration, development, and application work is done by teams. This mass assault upon technical problems is rendered necessary by competition and by the amazing complexity and the variety of avenues that require thorough exploration. Dr. Bronk, in his lecture of six years ago, recognized that the genesis of new ideas is catalyzed by the work and thought of others.

He, nevertheless, declared: "I know of no evidence which disproves the thesis that new ideas and concepts are formed within a single mind. Great scientific discoveries will be made by individuals who work without direction from others, as surely as will the creation of great music and sculpture and art."

I agree with this point wholeheartedly; in defense of the expediency of collectivism I can state that industrial management has become acutely conscious of this problem, and we have devised means to help keep such personal frustration to a minimum. Personalities differ and "teams" are made up of people whose individual traits and abilities are as nearly complementary as possible. Outstanding abilities are recognized, and creative individuals are promoted to group leaders and to research directors. For the creative individual, the changes are not made without a period of adjustment. This pattern of promoting the successful scientist to an executive, in some instances, may be a loss to creativity, and this procedure is being questioned in some quarters.

I can recall vividly my own transition from the comfortable, relatively simple furrow of entrancing specialization to the responsibility of director of research. From this position the horizons were wider, the laboratory larger; there were several research teams, each intent upon its own problem. Not only was there more formalizing of procedure; there were increased demands to know in detail more fields of endeavor. Gradually, I realized that the borderlines between the different specialized fields were like a pattern of farmlands from the air. The fallow ground in the fence rows appeared clearly to be the virgin places that would respond fastest to cultivation.

The research director's task is a demanding, often trying experience. He must expand his interests into a new plane that demands broader thinking. He must be concerned with the originality, the energy, the perseverance, and the quality of his men's work; not his own. He must deal with people, not with compounds and concepts; and people do not always react logically and in accordance with natural laws.

But this responsibility, unique to modern times, gives a director of research the opportunity to perform a new kind of creative work. His is a position of relative detachment. Through study of a mass of details he may discern trends or patterns. If he has the ability to see the forest in spite of the trees and logs which seem to block the road, he can often analyze and then synthesize an ingenious theory which brings order out of chaos. This may indeed be a major accomplishment, a valuable contribution to science. It is different in kind, however, from the creativity of which we have been speaking. Under these circumstances, the individualism of the group leader and research director, ideally, must be delicately balanced so that it does not intrude upon or frustrate the self-fulfillment of the subordinate members of the group.

CONCOMITANT WITH INDUSTRY'S growing understanding of the individual's problems and the strenuous efforts being made to make collective work self-rewarding with a minimum of strain, it is heartening to note that many large corporations have created posts of distinction for senior scientists, have relieved them of all directives and administrative duties, and have provided them facilities to work with at their own discretion. In an age of pragmatism, this step might appear to be somewhat iconoclastic.

To summarize, we have attempted to define creativity as a composite mosaic of imagination, curiosity, enthusiasm, and a high level of mental energy. We have further attempted to distinguish between the "act" and its "causation" and have separated the latter into logical elements which we have examined against the backdrop of the world in which we now live. We have found factors that appear to foster creativity; that appear to hinder its free exercise; that appear to have little or no bearing on it.

But now . . . can we conclude by suggesting some patterns of thought and action which might lead to the establishment of an atmosphere better suited to the growth and development of creativity both in pure and applied science?

One of the ways in which we can stimulate creativity, in my opinion, is to resolve the age-old division of interests between the "Thinker" and the "Doer." These terms provide us with a crude but practical distinction between the philosophies of the two types of intellectuals—the pure theorist and the pragmatist.

Woodrow Wilson maintained that in America the conflict between the man who thinks and the man who acts is inevitable. But today the maximum contribution from both is needed; there is a most acute need for harmony between the two philosophies.

The "thinker"—the pure theorist—in the past has usually been a person connected with a college or university. He has been pictured as living in an ivory tower. But this pattern has changed in America in the last twenty years. The "thinkers in science," the intellectual theorists of our institutions of learning, have come out of their remote, insulated towers to take active parts in our Government research activities. They have come into industry as consultants; they have become members and heads of scientific groups. This change has been applauded by many—but the question has been raised: Has this hindered our creativity in basic sciences?

The "doer"—the technologist—has shifted, too! He has become proficient in using the tools and the instruments that formerly were the property of the theorist. The mathematics of astronomy and theoretical physics has been applied to aeronautics and radar; the electronic computors built for the theorist's problems have been impressed into the service of weather forecasting, guided missile flight, and even market forecasting.

The technologist's invasion of the pure scientist's sphere is a matter of less concern than the descent of the theorist from his ivory tower. Perhaps this is because it is hard to break with tradition. Will the change disrupt the creativity we need so acutely for our defense, for keeping technology supplied with new raw material?

Temporarily, perhaps it may. But I do not believe that the pure intellectual in rubbing shoulders with practical men on practical problems has thereby traded his birthright, prostituted his calling, or entered upon a sterile marriage. On the contrary, I believe that if the "thinkers" and "doers" can come to a better understanding, can develop an appreciation of each other . . . the professional environment of both will become more conducive to creative work.

To promote such an understanding will require a period of adjustment, which we must face. As I see it, there is no turning back in these United States. It is highly doubtful that the pure scientist, once he has served on government research teams or actively contributed to technological development, can ever return to the serene, purely contemplative life. Since the masters have forsaken the ivory towers, it is questionable whether the pupils can be induced to re-climb the steep stairs that lead to solitude. Our man of science of the future will not be an isolated, insulated watcher of his private cosmos. What was true prior to 1940, the ordering that still prevails in Europe, will not have its counterpart in this age, in this nation.

It is not wishful thinking on my part to maintain that we can have a flourishing, vigorous growth of our own creativity in science . . . a mode, if you will, that is entirely unlike what we have witnessed in the past in Europe. The pattern is already forming. It is new; and we should not be afraid of it. It is a different pattern from the one that, admittedly, has produced some impressive discoveries in the past. But have we not already seen evidence that perhaps the new pattern will follow Hegel's theory of progressive synthesis?

ONE OF THE MOST AMAZING PHENOMENA I have ever witnessed was the skillful melting together of the ivory-tower pure scientists and tolerant technologists in the development of the atomic bomb. Out of this harnessing together of these "thinkers" and "doers" came the most amazing synergism. They catalyzed one another's creativity. The products of their individual efforts had the effect of two groups each dropping successive stepping stones across a stream—so that all could realize the common goal of getting to the other side.

The pure scientist has a tendency to resent the pragmatic approach of the applied scientist, primarily because he has, in his isolation in the rarefied atmosphere of pure science, lost touch with the rough world of practicality. As Theodore Parker has said "The scholar is to think with the sage and saint, but talk to the common man." The pure scholar has held himself, not necessarily above, but apart . . . not only from the public but from his fellow intellectual in technology.

The technologist, by his profession, is a valiant disciple of pragmatism. He may not understand the pure scholar. The role of the pure scholar in our democratic society has never been convincingly explained to him or to the public.

This meeting of the "thinker" and "doer" in science is an exciting promise-full challenge. To shorten the period of adjustment to the new pattern of collaboration should be the main objective of our educators.

Our future men of science should be conditioned to understand that pragmatism, the rigid code of practicality, is a good professional framework for some . . . but may be unacceptable to others. From undergraduate training upward—and it cannot be started too early—students of the sciences should be made to appreciate that some men are driven by a deep desire to add to the store of knowledge, that the challenge of discovery is rewarding whether it has immediate practical value or not . . . and that this, too, is good and right. Whatever path the science student chooses, he must be taught to realize that his choice is made on the basis of personal preference, with the firm conviction that neither the one nor the other is a superior calling.

We will develop, in my opinion, a most dynamic creativity in science if we can duplicate the empathy that exists in music, between the composer and the conductor. There have been many composers whose true genius would have been lost to the world if there had not been an equally talented conductor to interpret the music . . . so that it lived, so that it was handed down to posterity. Some pure theorist may argue that the composer creates his symphony as a personal fulfillment—music for music's sake—and that it brings him ample satisfaction as it plays itself in his mind. But I do not believe this happens. The rapport between the composer and conductor is so

(Continued on page 37)

AN INTERESTING CHAPTER IN THE SAGA OF AMERICA'S CHEMICAL INDUSTRY IS . . .

THE DIAMOND ALKALI STORY

This is the first of a series of articles on the origin, development, and product fields of the sustaining member companies of the Association reflecting the essential role of chemical science and industry in National Defense. The next such article will appear in an early issue.

It is realized that histories of all of the chemical companies included in the list of A.F.C.A.'s group members would together provide a most impressive mosaic of the contributions of the chemical industry to our national strength and preparedness.

However, in view of obvious publication limitations, it has been decided to confine this publication project initially to the sustaining member companies.—Ed.

By DONALD S. CARMICHAEL

Secretary of the Diamond Alkali Co., Cleveland, Ohio

WHY AND HOW ARE important industrial enterprises "born"?

To find the answers to these and related questions is to explore a fascinating facet of America's economic progress and national defense.

Such is the case with Diamond Alkali Company.

In the comparatively short span of less than half a century—but a few fleeting grains of sand in time's hourglass—the company has become one of the nation's leading producers of basic chemicals and derivative specialized products having a wide range of application throughout industry and agriculture.

It should be noted at the outset that, by itself, Diamond's history holds little significance; it is an unspectacular chronicle of steady, substantial growth.

But if viewed in broader perspective—as a representative chapter in the tale of a typically American enterprise in a typically American industry which, through intensely keen competition between its members, works hard to promote progress in peace for everyone and to strengthen and safeguard our security in war—then the Diamond story may be said to hold considerable importance and interest.

For as members of the Armed Forces Chemical Association so well know, the story of applied industrial chemistry is a stirring saga, one of the past quarter-century's signal developments on the American scene. Truly, it has no end. New chapters are being written almost daily.

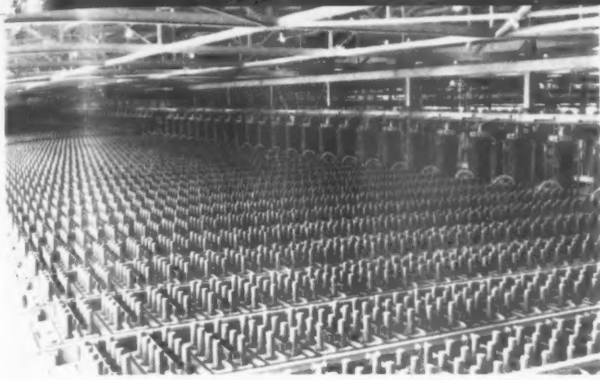
This parade of progress can be attributed chiefly to two factors: (1) the industry's ever-widening impact upon our economy, and (2) its continuous cascade of research developments and process improvements and their resultant diversification of both products and production.

With their contributions to the advancement of our way of life, standard of living and their preservation, development and diversification thus have been—and continue to be—the chemical industry's watchwords as it stands upon the threshold of future frontiers of economic progress and industrial achievement.

Basically, Diamond's experience offers no exception. It is an indispensable thread in this fabric woven by progress even though the company's role as a chemical producer has remained unheralded for the most part. The Diamond story, therefore, has failed to gain the

Diamond's Painesville (Ohio) Works, the company's oldest and largest plant is also the world's largest integrated alkali-manufacturing facility of its kind, covering some 250 acres.

Diamond's Deer Park Plant at Houston, Texas. Caustic soda, chlorine, perchlorethylene and polyvinyl chloride are among the chemicals produced here.



Mercury cell room at Diamond's Muscle Shoals Plant.

wide recognition that it deserves when measured by the company's solid, substantial growth strides, particularly in the years following World War II which have seen Diamond's emergence to its present position as a major producer of both inorganic and organic chemicals.

Since it began shortly after the turn of the century—in 1910, to be exact—Diamond history has been a forward march in steady cadence. The company did not, like Topsy, "just grow." Rather, this progress is recorded in terms of raw materials and production of basic chemicals from them, followed by the successful selection of carefully chosen paths of new possibilities and potentials.

How It Started

Chronologically, the story started 45 years ago, when a group of businessmen pooled their financial resources to establish a new chemical company for supplying soda ash to glassmakers. That was the objective initially. A factor destined to prove far more significant subsequently, however, revolved about the chemical industry's latent growth possibilities and economic potentials envisioned by the farsighted founders of the infant enterprise.

Organized in Pittsburgh, the company built its first plant two years later along the shores of Lake Erie just north of Painesville, Ohio.

Many sites for the infant venture were studied, but the Painesville area was selected in the belief its natural resources and man-made advantages made this location ideal with respect to both availability of raw materials and distribution of the initial product, soda ash.

These attributes included, among others:

1. A virtually inexhaustible supply of salt—a strata 300-ft thick about 200-ft below the surface;
2. Availability of water from Lake Erie, in unlimited quantity, for both product-processing and equipment-cooling purposes, and
3. Dependable, economical transportation, via water and rail routes, for both delivery of limestone from Michigan and coal from Southern Ohio and West Virginia to the plant and shipment of finished products to markets.

Production of soda ash started early in 1912, and customer demand proved so strong that within three years capacity was increased to 800 tons daily. A portion of this new capacity, however, was installed for the manufacture of caustic soda, which was launched in 1915.

During World War I, in response to Government request, Diamond doubled its caustic soda production early in 1918. The company also embarked upon the manufacture of bicarbonate of soda the same year.

Integration a Key Consideration

Because Diamond's founders were enamored of the chemical industry's growth possibilities, their long-term aim was to build an integrated operation not only for making basic alkalies, but also for utilizing a portion of them for further processing and "upgrading" into other versatile, useful chemicals. Thus, the expanding circle of new products called for new facilities and new ideas. Both followed at a steady pace during the next quarter-century.

The first step in this direction was taken in 1919, when Diamond became interested in producing silicate of soda, made by fusing sand and soda ash in various proportions, then dissolving in water. By the fall of 1920, a plant at Cincinnati was built and in production, turning out this chemical in liquid forms.

Because this product contains a high percentage of water, freight cost is a key consideration to purchasers. Consequently, distribution economics dictate close location of a silicate plant to the consuming market. It was only natural, therefore, that having "got its feet wet" in sodium silicates, Diamond by 1944 had established other silicate facilities in Jersey City, New Jersey; Lockport, New York, and Dallas, Texas.

That same year another plant was purchased from the Emeryville Chemical Company, Oakland, California. Subsequently, a sixth sodium silicate plant was established in Chicago, Illinois.

Expansion Through More Efficient Materials Utilization

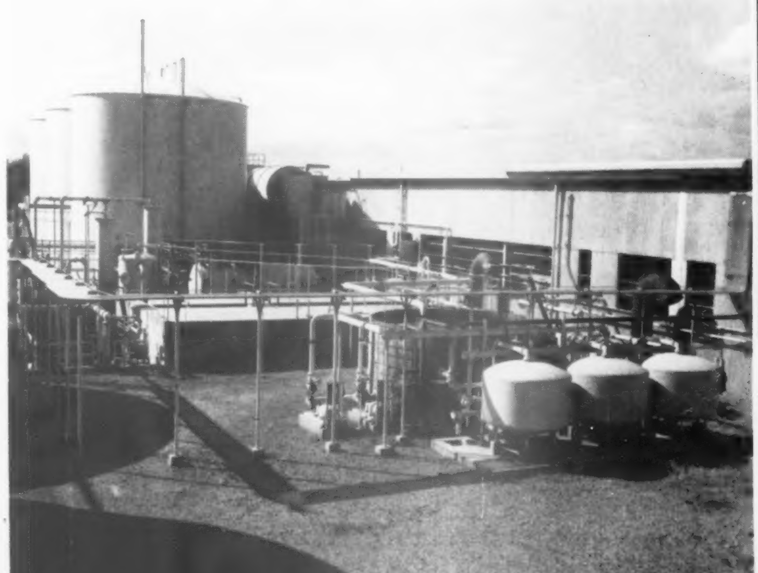
During this early development period, Diamond's diversification and expansion were sparked by its intense interest in more efficient and broader utilization of raw materials. So, in 1924, by-product coke ovens were installed at Painesville to recover ammonia, gas and tar distillates. Gas is used for fuel, ammonia and coke are required for soda ash. Benzene, toluene and related hydrocarbons are derived from the tar distillates.

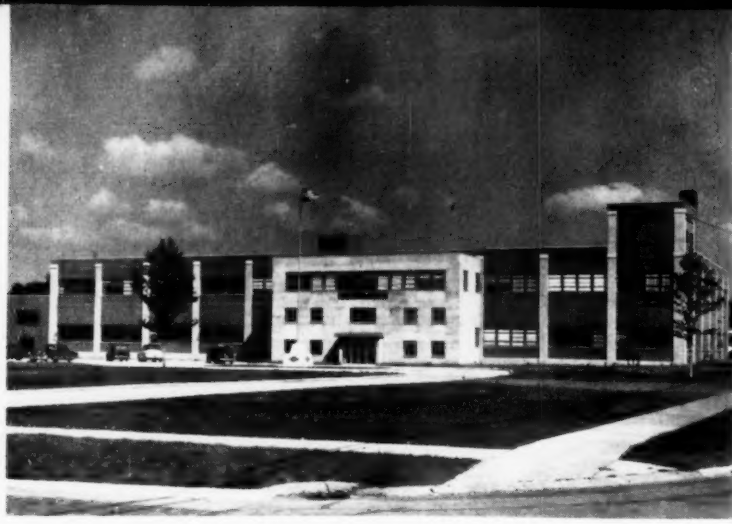
Building of these ovens served two purposes. First, it enabled Diamond to overcome a then-constantly-recurring shortage of coke, used for soda ash production. Second, it enabled the company to further broaden its product picture by the addition of premium-grade coke for foundaries.

Manufacture of caustic soda by the lime-soda process offered another opportunity for effecting still greater efficiency of raw materials utilization. One of the end-products of this process is a precipitated, free-flowing calcium carbonate of exceptionally high purity. A separate division was formed in 1925 to utilize this material.

The steady growth of this phase of Diamond's operations across the next six years then resulted in its expan-

Muscle Shoals at close range, showing water-treatment in foreground, depleted brine receivers, and acid storage and chlorination equipment. Large tanks at left are for filtered brine storage.





Home of Diamond's exploratory research and development work is the Diamond Research Center near the company's Painesville (Ohio) Plant.

sion to prepare calcium carbonates surface-treated by a patented process; in 1937, these facilities were further increased for the production of colloidal-type precipitated calcium carbonates, which have since found extensive usage in the paint, rubber, textile and paper industries among others.

Waste limestone screenings not adaptable for soda ash manufacture led in 1925 to the construction of a cement plant at Painesville. Today, it is a leading factor in Northern Ohio's cement industry.

The following year, the Buckeye Soda Company (now part of Diamond's Silicate, Detergent, Calcium Division) was organized to package sal soda, lye and baking soda for household use.

Two important developments brought this initial integration era in Diamond's history to a close. These were the manufacture of chlorine and the production of bichromate of soda. Because of Diamond's own salt beds and power-generating facilities in Painesville, it was a natural corollary development for the company to enter chlorine production. Accordingly, an electrolytic plant was put on stream in 1929. Its capacity has since undergone a number of sizable expansions.

Soda ash is an essential raw material for bichromate of soda: hence, it was equally logical in this instance also to become interested in producing this chemical. Production was consequently started in 1931.

Other significant moves followed in the ensuing years prior to World War II. They included the manufacture of carbon tetrachloride, and the development of specialized detergents and cleansers for use in the dairy and bottling industries as well as in laundries.

Three-Fold War Production Job Accomplished

Of Diamond's many contributions to Uncle Sam's military production program during the war period, those involving the company's operations directly on its own production line were marked chiefly by three major developments:

1. Manufacture of magnesium metal for aircraft production;
2. Manufacture of silicate of soda for production of catalysts essential to the production of high-octane gasoline; and
3. Development and manufacture of "Chlorowax," a chlorinated paraffin.

Early in 1941, when national defense was fast becoming "the order of the day" along the industrial front, the Government requested Diamond to make metallic magnesium. Because this operation entails electrolytic decomposition of magnesium chloride, Diamond found it necessary to develop a method for producing this material.

Diamond engineers accomplished this objective through adapting certain portions of the basic alkali process and applying these adaptations to the treatment of dolomitic limestone. As Diamond was getting ready to take over this production assignment, the Defense Plant Corporation constructed a plant for this purpose adjacent to the Painesville plant. Completed and put into operation in September 1942, it soon exceeded its rated capacity.

Operated by Diamond through the Diamond Magnesium Company, an affiliate organized specifically to carry out this task, this facility remained in operation until late 1945, long after other wartime magnesium production facilities had closed down. When the Korean crisis came in 1951, the Diamond Magnesium Plant was reactivated at Government request, and remained in operation until mid-1953, when it again was "mothballed" as a stand-by facility for future defense needs.

As many will recall, the demand of the armed forces for high-octane aviation gasoline during the early war days prompted the petroleum industry to construct a number of additional new refineries. The new "cracking" processes required a large volume of catalysts.

To produce one such catalyst, Diamond in 1943 "joined hands" with the M. W. Kellogg Company, engineers and builders of petroleum refining equipment, to form the Diakel Corporation. To secure silicate of soda, the principal raw material required, a plant was built at Cincinnati adjacent to Diamond's facility there. It produced petroleum catalyst in large, steady volume until the end of the war, when it was declared surplus by the Government and purchased by another chemical concern.

An original development of Diamond research, Chlorowax—a synthetic resin made from paraffin wax and chlorine—almost immediately after its introduction became widely used in the manufacture of fire-retardant paints for application aboard Navy vessels, in the production of tracer bullets, and in flame-resistant compounds for impregnating military textiles, such as camouflage nets, tents, fabrics, etc.

Diamond's original Chlorowax was liquid, containing 40% chlorine by weight. Extensive exploratory and applied research later yielded Chlorowax 70, a resinous solid containing 70% chlorine by weight. These and other grades since developed have come to enjoy steadily expanded usage in the manufacture of varied civilian products.

These three major developments, then—magnesium metal manufacture, silicate of soda production, development and production of Chlorowax—were, as indicated previously, Diamond's own direct contributions to victory. But indirectly, in countless other industries and their plants, factories, shops and mills, the company also contributed importantly to military production by virtue of the fact that many Diamond products were available only to essential industries under allocation by the War Production Board. Among these were chlorine, carbon tetrachloride, sodium bichromate, sodium metasilicate, and certain grades of calcium carbonate.

Postwar Strides in Seven-League Boots

Following the war and the nation's return to a peacetime economy, growth again became the dominant influence in the Diamond pattern. Whereas its earlier development represented substantial strides on the surface,

the company actually had failed to match the giant steps forward of the chemical industry. But the years since 1945 tell a far different story—a growth story of "making up for lost time," so to speak.

In 1946, Diamond launched a vigorous, forward-looking program of capital expenditures for the expansion of its productive capacity, modernization of existing facilities to increase efficiency and reduce costs, and diversification of plant location and products. From the first of 1946 to mid-1955, the company has spent about $100 million to strengthen its position in inorganic chemicals, to extend its activities into organics, and to broaden its operations, both geographically and productwise.

The first phase of this ambitious program, calling for plant modernization, expansion and diversification, was completed in 1950 at an outlay of about $41 million, high-lighted by the following developments.

In 1948, an electrolytic chlorine-caustic soda plant was put on stream at Houston, Texas, to serve the southwest. That same year Diamond acquired The Martin Dennis Company, Kearny, N. J., pioneer producers of chromate and bichromate of soda. These facilities along with those at Painesville have since been rehabilitated and expanded. A further extension of Diamond's bichromate of soda business came in 1950 with the acquisition of the chromic acid business of E. I. duPont de Nemours & Company, Inc.

At the Army Chemical Center, Maryland, and at Pine Bluff Arsenal, Arkansas, where Diamond operates chlorine-caustic soda plants under government leases, processing facilities were streamlined, new equipment installed, and production capacity boosted substantially.

In the sodium silicate field, a plant and warehouse at Chicago, a detergent plant at Dallas, and an additional furnace at the Cincinnati plant were constructed. Expansion of silicate capacity was prompted primarily by the rapid growth of synthetic catalysts used by the oil industry in the production of high-octane gasoline and which requires substantial quantities of silicate.

New facilities were constructed at Painesville for chlorinated paraffin, anhydrous hydrogen chloride (used with other chemicals), crystal sesquicarbonate of soda (used mainly in detergents), and other products. Power and certain other service facilities at Painesville were expanded and modernized.

In 1951, Diamond embarked upon a further program designed to expand its activities in organic chemicals (especially chlorine-based plastics, solvents and other petrochemicals, insecticides and other agricultural chemicals), and to provide additional chlorine capacity to meet expanded demands. Outlays for this second phase of Diamond's postwar progress-capital improvement program totals about $59-million.

Major projects covered by this expenditure included:

1. Further expansion of the chlor-alkali plant at Houston.
2. Acquisition in 1951 of Kolker Chemical Works, Inc., a producer of organic insecticides and agricultural chemicals, with plants at Houston, and Newark, New Jersey.
3. Expansion of chrome operations at Kearny, New Jersey.
4. Building of increased capacity at the Cincinnati and Dallas silicate plants.
5. Construction of a perchlorethylene plant and a polyvinyl chloride resin plant at Houston.
6. Acquisition in 1953 of Belle Alkali Company at Belle, West Virginia, producers of chloromethanes and muriatic acid.

Two Latest Developments Spark Further Growth

This list would be incomplete without the latest two developments in Diamond's dynamic change and continuing growth. Both took place earlier this year.

First and most important was the acquisition of the Government-owned chlorine-caustic soda plant at Muscle Shoals, Alabama. Built at a cost of approximately $21,-million early in the Korean crisis when a chlorine shortage was feared imminent, this plant is one of the largest, most modern and complete chemical installations of its kind.

Employing the mercury cell process, this plant has a capacity of 225 tons of chlorine and 252 tons of caustic soda per day. Put into limited operation in the spring, it is now being operated at near-capacity production.

This new facility holds a high potential for Diamond. It gives the company new marketing frontiers for chlorine and caustic soda, and broadens its customer service perimeter.

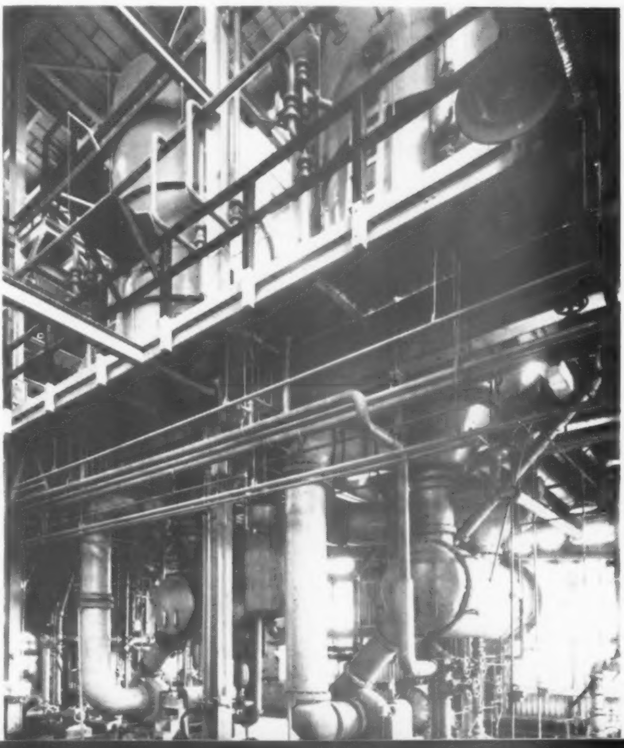
Second item of importance in 1955 is another expansion move that was made early this year, when Diamond Alkali formed, with Virginia-Carolina Chemical Corporation, a new company known as Diamond Black Leaf Company. In taking over V-C's Black Leaf Products Division, the new firm carries on the manufacture and marketing of America's oldest and most widely known brand of pesticides, insecticides and herbicides.

By this move, Diamond has acquired formulating facilities in Richmond, Virginia; Louisville, Kentucky; Montgomery, Alabama, and Waco, Texas. Another plus is the acquisition of a well-established brand name, known the world over to commercial growers and home gardeners alike.

So, as a result of these various steps taken in the relatively short span of five decades, Diamond today operates 18 plants. Reaching from the Atlantic Seaboard to the Pacific coast and from Lake Erie to the Gulf Coast, they are dotted across the map, according to the dictates of shipping, marketing, and availability of raw materials.

And instead of the few basic alkalies which accounted

These evaporators at Diamond's plant at the Army Chemical Center, Maryland, are used for processing caustic soda.



THE DIAMOND ALKALI STORY

(Continued from preceding page)

for the lion's share of the company's production during its early years, Diamond products presently number well in excess of 100. Principal products or product-groups are: soda ash, caustic soda, chlorine, chloromethanes, bicarbonate of soda, sodium silicates, calcium carbonates, chromates, specialized chemicals, organic chemicals, plastics, agricultural chemicals, and cement and coke and coke by-products.

Thus, from this coast-to-coast network of plants, Diamond contributes basic chemicals to every major industry throughout the nation: to metal, chemicals, glass, rubber, textiles, lumber, soap, paint, plastics, petroleum, building materials, and to the service industries such as dry cleaning and laundering. Maintenance needs and sanitation requirements in dairying, bottling, meat packing and food processing operations also call for Diamond chemicals in the interest of keeping quality control standards high at economical cost.

Diamond's business is a broad base to all industries. The consumer seldom sees or buys its products as chemicals. But almost everything man uses or needs in his daily living—in war or peace—either contains as ingredients the basic chemicals Diamond makes, or requires them in one or more manufacturing stages. It is this fact which gives truth to Diamond's slogan, "Chemicals You Live By."

The future?

That is the most provocative aspect of the Diamond story!

Inventions are emerging in an unending stream from the chemical industries laboratories. They have been devised mostly from the inexhaustible vagaries of organic compounds—a field in which, as we have seen, Diamond has become increasingly interested in recent years.

Many others are now in the pilot stage, and a substantial number of these new products and processes are destined to open up markets for Diamond. Tomorrow, as yesterday, as a fast-growing member of America's fastest-growing industry, Diamond can look foward to playing an ever-increasing role in making possible continuing betterment in our way of life and its preservation in times of peril.

NATIONAL ACADEMY OF SCIENCES

(Continued from page 6)

power it turned to the Academy-Research Council to evaluate and recommend recipients for its fellowships. Through these programs superior young scientists are identified and encouraged in their research particularly at a time in their careers when financial pressures might otherwise limit their freedom for research or discourage them from it altogether.

PERSONAL CONTACTS among individuals working in related fields provide another important means by which science is stimulated. The Academy-Research Council does much to encourage such fruitful encounters through the sponsorship of dozens of scientific meetings, conferences and symposia each year. At the Autumn Meeting and the Annual Meeting of the Academy hundreds of individuals gather to hear and discuss scientific papers presented by members of the Academy and their guests. The titles of some of the other conferences and symposia convened last year will give an idea of the variety of the fields of research in which scientists are gathered together under Academy-Research Council auspices; for example, the 23rd Annual Conference on Electrical Insulation, Conference on Radiocarbon Dating, the 3rd National Clay Minerals Conference, Conference on Red Cell Metabolism, Symposium on Colored Aerial Photography, Symposium on Theories of Human Behavior in Extreme Situations, Conference on Unclassified Research Reactors, to name but a few. During the past few years the Academy has also sponsored a series of afternoon lectures by members of the Academy or distinguished guests to which the scientific public is invited. These are followed by informal teas that provide opportunity for further discussions among the audience and the lecturer. Last year seven such lectures were given including one of particular interest to chemists by Dr. Joel Hildebrand, President of the American Chemical Society, who spoke on the fundamental properties of acids and bases. Dr. Wendell M. Stanley, a chemist who was deflected into biochemistry by his interest in the crystallization of viruses, lectured on the nature of living systems from the point of view of virology.

The financial support for the extensive programs of the Academy-Research Council is derived from many sources, public and private. Its handsome building located near the Lincoln Memorial on Constitution Avenue in Washington, D. C. was made possible by a gift of $5 million from the Carnegie Corporation of New York, a part of which was applied to the Academy's endowment, now exceeding $6 million. A number of trust funds for specific purposes have been established by gift and bequest. The expenditures of the Academy for all purposes in 1954-55 totaled $5,900,000 of which $1,600,000 was provided from endowment income and contributions and contracts from non-governmental sources. These figures are large but they do not reflect the true magnitude of the program. The Academy-Research Council's Committee on Growth, for example, advises the American Cancer Society on the specific distribution of more than $3 million annually for projects in cancer research that are not administered through the Academy's business office. There are several other activities of this kind. Moreover financial statements can never show the priceless and essential ingredient of scientific work, the skill and wisdom of the individuals that make it possible. In the Academy-Research Council's balance sheet the tens of thousands of man-hours contributed by the scientists of America to its work do not appear, for their only compensation is the satisfaction they derive from seeing important work well done.

THIS SPIRIT OF LEADERSHIP and devotion is the essence of the National Academy of Sciences-National Research Council. Its fundamental aim was expressed for us a very long time ago by Aristotle. I would like to conclude this article with his words which are inscribed on the frieze about our building as a constant reminder of our aim:

"The search for Truth is in one way hard and in another easy. For it is evident that no one can master it fully nor miss it wholly. But each adds a little to our knowledge of Nature, and from all the facts assembled there arises a certain grandeur."

THE ISSUE OF GAS WARFARE

(Continued from page 21)

tion the prospect of effective agreement among nations on the curtailment of armaments appeared to have vanished. In line, possibly, with this trend, Congress passed in 1937 a bill (S.1284) to change the designation of the Chemical Warfare Service to "Chemical Corps."[15]

This the President promptly vetoed. The reasons given in the Roosevelt veto message clearly expressed the White House attitude and, *ipso facto*, that of the United States Government:[16]

> **It has been and is the policy of this Government to do everything in its power to outlaw the use of chemicals in warfare. Such use is inhuman and contrary to what modern civilization should stand for.**
>
> **I am doing everything in my power to discourage the use of gases and other chemicals in any war between nations. While, unfortunately, the defensive necessities of the United States call for study of the use of chemicals in warfare, I do not want the Government of the United States to do anything to aggrandize or make permanent any special bureau of the Army or the Navy engaged in these studies. I hope the time will come when the Chemical Warfare Service can be entirely abolished.**
>
> **To dignify this Service by calling it the "Chemical Corps" is, in my judgement, contrary to a sound policy.**

The War Department and Gas Warfare

Beginning in 1921 and continuing until 1941, the Chemical Warfare Service was under almost continuous scrutiny by the War Department General Staff (WDGS). During these years there was scarcely a time when the CWS felt that it enjoyed undisputed membership on the War Department team. Hence a great deal of energy was continually expended by the CWS in defending its statutory position. This fact had considerable bearing on the development of the new service.

The questions most frequently raised by the War Department were: Could the Chemical Warfare Service be eliminated and its duties distributed among other services: Could the Chemical Warfare Service be relieved of combat functions and its activities limited to technical and supply duties and to defensive training?

In 1924 the WDGS phrased a sentence which, constantly repeated in later years, came to be generally accepted as a statement of policy and a guide to the activities of CWS: Our peacetime preparations in chemical warfare will be based on opposing effectively any enemy employing chemical weapons.[17]

This statement was based on War Department policy No. 467, which attempted to clarify preceding general orders and other instructions as to the interpretation of Section 12a, National Defense Act, particularly in the light of current developments toward international limitation of armaments. It had the merit of clearly stating an obviously desirable objective, yet the means to be followed to this end proved to be subject to widely varying interpretations. Some of the difficulties being encountered were brought to the attention of the War Department by the Chief, CWS (Maj. Gen. Amos A. Fries)[18] in 1926, when some liberalizing of existing policy as to offensive means was proposed.[19] The staff study of CWS functions which followed carefully reviewed all the preceding actions and pointed to still further investigations that needed to be made, but did not lead to immediate change in standing instructions.[20] The War Department by this time had definitely veered away from planning the type of positional warfare characteristic of the campaigns in France in 1917 and 1918 and with which large scale gas operations staged by chemical troops seemed intimately associated. Consequently the organization of special gas troops was increasingly challenged and the employment of gas by arms other than the CWS was increasingly favored by the staff. The CWS view was that gas had important uses in a war of movement as well as in static operations and that technical considerations necessitated the employment of special gas troops in either situation. These differing attitudes were never wholly reconciled, although at times the General Staff view appears to have been maintained somewhat less resolutely than that of the Chemical Warfare Service.

The mission of the Chemical Warfare Service with respect to its principal preoccupation, gas warfare, was therefore somewhat complex. Primarily the CWS was expected to provide insurance for American military forces against the shock of sudden gas attack. Hand in hand with this went responsibility for maintaining a state of readiness for quick retaliation. These two constituted explicit responsibilities. In a broader sense, an implicit function of the CWS was to provide military support for a national policy, that of dissuading others from resorting to the gas weapon. This was accomplished, as matters turned out, more by the strength of our preparedness for toxic warfare than by the cogency of political agreements.

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[15] This change was eventually effected by P.L. 607, 79th Congress, 2 August 1946.

[16] Copy in CWS 011/1-20

[17] Ltr. AGO to C CWS, 7 Jan 24, sub: Chemical War Service's Functions. AG 321 Functions of CWS.

[18] P. L. 457, signed 24 Feb 25, raised the rank of the Chief, CWS from Brig. Gen. to Maj. Gen.

[19] Ltr. C CWS to TAG, 9 June 26, sub: Functions of the CWS AG 321.94

[20] Memo OACofS, G-3, for CofS, 5 Nov 26, sub: CWS Functions. AG 321.94 Sec 1. Functions of CWS.

ACC AIR FIELD NAMED IN HONOR OF MAJ. WEIDE

EDGEWOOD, MD., The Army airfield at Army Chemical Center, Md., was dedicated on October 6 as Weide Army Airfield by Post Commander Brigadier General John R. Burns in memory of the late Major Edward James Weide, former Air Force commander of the 6572d Chemical Test Squadron located here.

Born in Menominee on June 2, 1912, Major Weide died September 20, 1954, at Iron Mountain, Mich., after a long illness.

He commanded the Chemical Test Squadron at Army Chemical Center from September 1951 to September 1952 and later was commander of the 6570th test group (Chemical and Ordnance) at Aberdeen Proving Ground, an adjoining Army post. He was awarded the commendation medal and also received a letter of achievement.

Major Weide joined the Air Force in June 1942. He flew in Europe and Africa with the Air Transport Command during World War II.

NEW ASSIGNMENT

Mr. Glenn A. Hutt, a vice president of A.F.C.A., has been made Vice President, Building Products Division, of Ferro Corporation, Cleveland, Ohio. Mr. Hutt has been with Ferro for 22 years and recently served as Vice President of Advertising and Market Research. He is President of the Porcelain Enamel Institute.

CIVIL DEFENSE SHELTER DESIGNS

Designs for a series of home and industrial shelters "to protect Americans in the nuclear age" were announced on September 18 by the Federal Civil Defense Administration.

The shelters are designed to protect against blast, heat, and radiological effects in areas outside the total-destruction zones of nuclear weapons.

FCDA Administrator Val Peterson's announcement re-emphasized the basic tactics of civil defense—evacuation and shelter—declaring that "saving lives will almost certainly require some combination of the two in any area under attack.

"If there is sufficient warning time, we must and will evacuate our critical target cities," Administrator Peterson said.

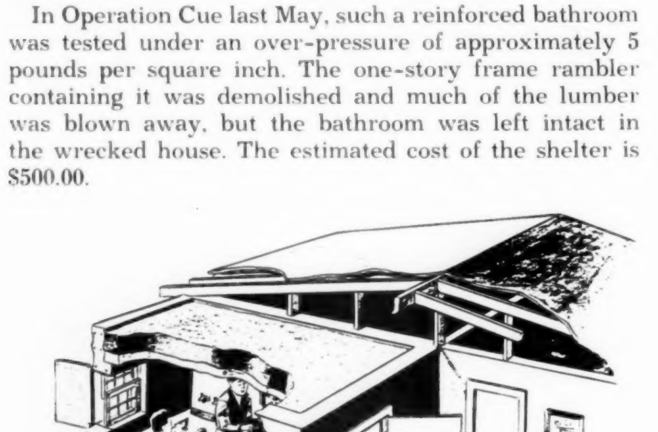
However, the FCAA Administrator also emphasized that evacuation alone is not enough since its success depends upon warning time and also because there may be a threat of fallout after an attack. The announcement repeated previous urging for citizens living 10 or more miles from the presumed aiming point of enemy bombs to construct home shelters. Shelters closer than 10 miles are feasible, the announcement stated, if outside the "cratering area" of the bomb but their cost increases markedly.

Pictured herewith are sketches of three of the five types of shelters and descriptive matter contained in the FCDA announcement. There is also a design for a 40-person shelter and one for four persons made from a reinforced concrete cattle pass pipe.

REINFORCED CONCRETE BATHROOM

A shelter designed for the increasing number of homes which do not have basements has been developed and tested by the Federal Civil Defense Administration. This blast-resistant shelter is created simply by making the walls and ceiling of the bathroom of reinforced concrete 8 inches thick. The bathroom was selected because it is a small room, found in every modern home.

In Operation Cue last May, such a reinforced bathroom was tested under an over-pressure of approximately 5 pounds per square inch. The one-story frame rambler containing it was demolished and much of the lumber was blown away, but the bathroom was left intact in the wrecked house. The estimated cost of the shelter is $500.00.

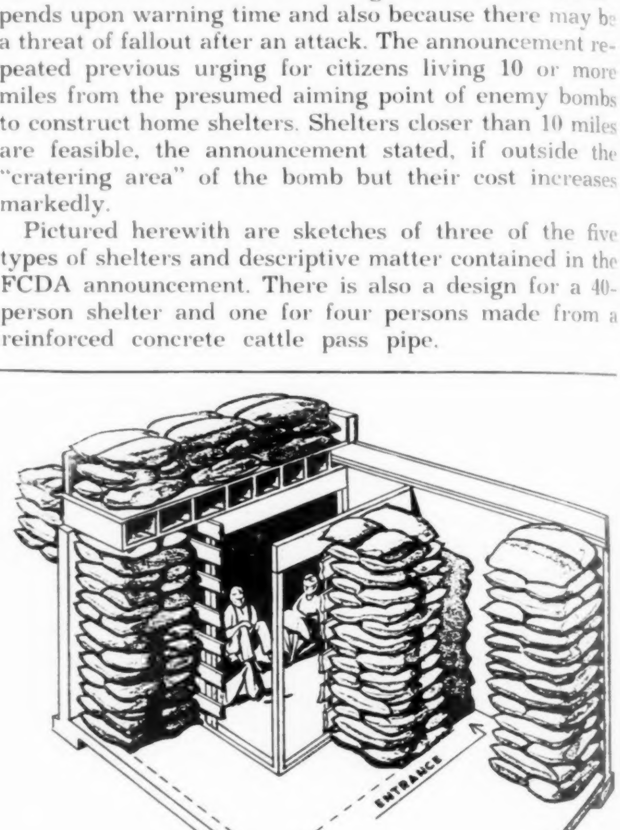


FALLOUT SHELTER

A fallout shelter may be built in the corner of a basement, consisting of a sturdy framework to support enough bags filled with earth, sand or similar material so that radiation can be reduced to a safe level.

This is a modification of a corner-room basement shelter for blast protection closer to a probable bomb detonation, of much heavier construction to carry the load of filled sandbags and the debris of the house above.

This is the only one of this set of shelters which can be done easily by a householder for himself . . . The one simple thing to remember about radioactive fallout is that almost any kind of cover will afford at least some protection against its worst effects.

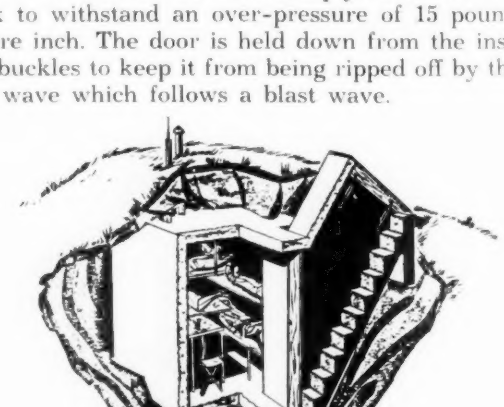


INTERMEDIATE REINFORCED CONCRETE SHELTER

If there is insufficient warning time to permit complete evacuation, shelters should be available at intermediate points. One of the designs for such a shelter and for shelter in the peripheral areas of our larger cities produced by the Federal Civil Defense Administration, to protect 4 to 10 persons, is shown here.

This shelter can be built of reinforced concrete for about $1,100, or of reinforced masonry blocks for slightly less. The roof is a reinforced slab 6 inches thick, and has about 2 feet 10 inches of earth above it.

The entrance is closed with a plywood door 2 inches thick to withstand an over-pressure of 15 pounds per square inch. The door is held down from the inside by turnbuckles to keep it from being ripped off by the suction wave which follows a blast wave.



BOOK REVIEW

MIDWAY, THE BATTLE THAT DOOMED JAPAN—The Japanese Navy's Story, By Mitsuo Fuchida and Masatake Okumiya. Published by the U. S. Naval Institute, Annapolis, Md., $4.50.

One need not be a student of naval operations or even familiar with nautical terms for easy reading of this candid account of the Japanese Navy's disastrous bid for quick victory in World War II. The book was written by two former officers of the now nonexistent Imperial Japanese Navy, Mitsuo Fuchida, Captain, and Masatake Okumiya, Commander, both naval aviators. Subsequently, it was translated into English by another former Japanese naval Commander, Masataka Chihaya, but it appears that very extensive revision, editing, and historical checking of the original text, including annotation which the original lacked, have been made under the supervision of the U. S. Naval Institute. The editors, Clarke H. Kawakami and Roger Pineau, working under the auspices of the Institute, have produced in English a well-organized and smoothly flowing narrative which laymen can readily understand.

The scope of the book is broader than its title. The account begins with a discussion of the evolution of Japanese World War II naval strategy. It states and explains the somewhat paradoxical situation of separate and distinct strategic interests of the Imperial Japanese Navy and the Japanese Army. It appears that the Japanese Navy's strategy and war planning had long been dominated by the idea of the United States as the potential enemy, whereas the Japanese Army's policy of northward expansion had led it mainly to regard Russia in that light.

Early in the book there comes to the reader, at least it did to this reviewer, something of a shock in the fairly detailed and bald account of the conception and execution of the attack on Pearl Harbor. This is written in the first person by Author Fuchida who was none other than the commander of the Japanese Naval Air Forces that carried out the attack. It may be noted here that the decision for this attack came only after consideration of a much different plan, namely, to launch the initial naval operations in the South Pacific with a view to quick seizure of oil resources there. We leave the narrative here to the reader, but it should be pointed out that Pearl Harbor was not an unqualified success from the Japanese point of view. They had hoped by the attack to destroy American aircraft carriers, but these, they learned with chagrin, were not present at Pearl Harbor to receive the unheralded Japanese blow.

The balance of the book takes the reader through the initial concept and planning for the Midway operation, the object of which was to draw forth and destroy U. S. naval power in the Pacific. This narrative of the planning phase and the preliminary war gaming of the operation is interspersed by comments and descriptive touches of the atmosphere and personal relationships at the Japanese Naval War College and Naval General Staff. The account ends with an analysis of the battle, presenting with apparent complete frankness what the authors consider were the failures which brought dismay and defeat to the Japanese Navy. Inadequate air reconnaissance, inadequate intelligence, and communications difficulties, as well as undue dispersion of the Combined Fleet into widely separated groups are cited. It appears that the defeat of the Japanese Combined Fleet, referred to as the greatest sea force ever assembled, was carefully kept from the Japanese people during the war and that they only learned of what happened at Midway with the original publication of this book by the authors in 1951.

Not the least interesting parts of this book are the several introductory statements, including a foreword by Admiral Raymond A. Spruance, USN-retired; an introduction by former Admiral Nobutake Kondo of the Japanese Navy; an authors' preface; an editors' preface; and also, the publisher's note by the U. S. Naval Institute. In addition, the explanatory matter by the Naval Institute presented on the outside paper jacket of the book is of interest. In this the battle of Midway is compared, as to its influence on the course of the war to which it pertained, with the battle of Gettysburg. It is pointed out that just as Gettysburg marked the turning of the tide in the Civil War, so did Midway bring upset in the fortunes of Japanese Navy forces in the Pacific and foreshadow the doom that the Japanese Navy had invited by its attack on Pearl Harbor. "For this reason," the Institute's account states, "Midway, like Gettysburg, will continue to challenge study for decades to come."—J.C. MacA.

CREATIVITY IN SCIENCE

(Continued from page 29)

deeply ingrained, the empathy so complete, that the rapture of the original creative work is almost synonymous with its public rendition.

Returning to science, what heights might our creativity attain if the pure theorist and the engineer entered a collaboration as close as the composer and conductor? Who but the engineer or technologist has the ability to understand and appreciate and apply the creative work of the theorist? Who but the theorist can better guide and inspire the particular kind of creativity possessed by the engineer or technologist? Our people—in government, industry, and the home—must come to understand that for the fruits they are enjoying they owe a debt of gratitude to *both* the basic scientist *and* the engineer.

This symbiosis of the theorist and the technologist is the new pattern for creative science in America.

Let the pure scientist find his own place in the new order, provided he does not, through misplaced nostalgia or ingrained habit, return to his ivory tower. The change is upon us. Our social background has conditioned the American people to expect it.

Our people understand technology, are more appreciative of its products than any other people on earth. Our Sunday mechanics keep upwards of fifty million internal-combustion vehicles in good repair; our farmers can rig up an irrigation pump; even our housewives can install a new light switch or base plug and properly employ chemical bleaches, household disinfectants, and selective herbicides.

Although the public understands and accepts science and technology, they do not understand theorists and technologists—have little acquaintance with the personality types or the ordering of their professional lives. The role of the scientist in our democratic society has never been explained.

Thus we have outlined two major tasks—one for the educator and one for the molders of public opinion.

When the scientist feels secure in his social framework, when he enjoys a sympathetic rapport between the philosophies of the theorist and the pragmatist—then, I am convinced, we shall see a synergized creativity which will surpass anything we have ever known.

THE FIRST ANNUAL MEETING OF THE ASSOCIATION OF THE U. S. ARMY

THE ASSOCIATION of the United States Army, favored with ideal weather and attendance of a large part of the Army's top rank, including the Secretary and the Chief of Staff, held its first annual meeting at Fort Benning, Ga., the Infantry Center, on October 21 and 22.

The impressive two-day outdoor-indoor program emphasized the role of the Army as one of increasing importance in the atomic age, both as a deterrent of war and as a bulwark of national defense should war come.

Following a full day of outdoor presentations, including a march-past of mechanized weapons and equipment, elaborate static exhibits, and a demonstration of fire power, came the reception and banquet. A letter of salutation and congratulation from President Eisenhower, sent from Denver, was read. The Honorable Wilbur M. Brucker, Secretary of the Army, was the principal speaker. Lt. General Walter L. Weible, Deputy Chief of Staff for Operations and Administration, presided in the absence of General Lyman L. Lemnitzer, president of the Association. General Lemnitzer, on duty in the Far East as commander-in-chief of the Far East Command and commander-in-chief of the United Nations Command, sent a message which was read at the meeting.

The Honorable
WILBUR M. BRUCKER
Secretary of the Army

Secretary Brucker, former governor of Michigan and a veteran of World War I, is not new to today's Army, having before his recent appointment as Secretary, been the General Counsel of the Department of Defense. However, to many of the 500 or more visitors, mostly officers, who were present, this meeting served as his introduction. His banquet speech sounded the theme of the meeting, which was that while the Army moves in step with the latest developments in technology, it is still essentially upon men of fortitude and character, as exemplified by the trained soldier, that the Nation's defenses depend. In this connection Secretary Brucker said: "Not one of the things displayed here today—no matter how great a miracle of technology it may be—is, by itself, of the slightest importance to our national security. Standing alone, each is inert and useless, incapable of providing a scintilla of military power. Each has value and significance only as an integral, functional element of a military system. It takes trained soldiers to do the job."

TOUCHING ON THE current missions and obligations of the Army, Secretary Brucker continued, "This Army is a mighty organization . . . It contains over a million uniformed men contributing to our defense at posts of duty throughout our own land, and in 73 foreign countries and eight other foreign areas. In addition, the Army has nearly 700,000 civilian employees and supporting personnel. The Army is backed up by more than 40 billion dollars worth of property, of which over 25 billion dollars worth are weapons and equipment. The Army is not only the hard core of our own national defense but is also one of the central elements of the collective strength of the Free World. In addition to providing major combat elements to fight alongside our allies, our Army assists in the training of more than 200 of their divisions . . . I believe the Army is an indispensable component of our national security. Nothing has occurred on the world scene that diminishes the fundamental role of land forces . . ."

Both in his banquet speech and in a press conference the next day, Secretary Brucker dealt at some length

Fort Benning, Ga., October 21. H-21 heliocopters lift in 75-mm pack howitzers at Lawson Army Air Field demonstration at meeting of the Association of the U. S. Army.

Fort Benning, Ga., October 21. Left to right: Lt. Col. John L. Carson, chairman of the Chemical Committee of The Infantry School's Tactical Department; Brig. Gen. John R. Burns, commander of the Army Chemical Center and Research and Engineering Command in Maryland; Major Gen. William M. Creasy, the Army's Chief Chemical Officer; and C. R. Davis, Assistant Secretary of the Army, view Chemical Corps exhibit which exemplifies the use of smoke to reduce atomic casualties from fire, at the meeting of the Association of the U. S. Army.

with the Reserve Forces Act of 1955. He said that the Army would carry out the provisions of the new Reserve Act to the letter and expressed his confidence in the success of the new reserve program. In the press conference he emphasized particularly the essential role of the Reserve unit commanders in the program and stated that the Army would give them the fullest possible support. "It is incumbent upon the Army—each of us—to see that the program works," he said, and added, "The Reserve Forces Act of 1955 will not alone give us the strength we need . . . The Reserve Forces Act is not a cure-all, even for our military manpower problem. Greater willingness to serve the Nation, and a reawakened responsibility on the part of our people toward the Nation must precede if it is to achieve any worthwhile goal.

"The building of a strong military reserve to supplement the standing Army is in line with a vaunted concept to which the Nation must return if it is to retain its birthright . . .

"The all-important mission of the Army is to uphold the interests of the United States in peace, in cold war or in a shooting war. This means that the Army must be mobile and flexible—prepared to move on short notice by land, sea, and air to fight any enemy, any time, any place. Paramount in peace or in cold war is its mission to deter aggression—to prevent war by being thoroughly prepared for it . . ."

In the military displays of equipment and exercises, the visitors were shown the latest Army developments in guided missiles, artillery and tanks. There was also an impressive demonstration of the use of helicopters and light aircraft, which presently constitute the Army's aviation, for quick redistribution of troops and for their support by air-transported field guns and automotive equipment as well as ammunition and other suppiles.

IMPRESSIVE AS WERE these present day means, it remained for Lt. General James M. Gavin, Chief of the Army's research and development program, to spark the imagination of his audience with his prediction of weapons to come. Addressing the gathering at its session on the second day, General Gavin said in part as follows: "In the uncertain world of tomorrow, the United States faces the need for greater military preparedness than ever before. As the Free World's leader, our nation seeks to prevent aggression in *any* form. The military role in supporting this national policy is to be able to win wars, large or small, atomic or non-atomic.

"This is a very big order. It establishes a new function for the Army; that is, in addition to being able to mobilize for a large-scale war, the Army must have sizable forces in being, ready to move by land, sea, or air and *fight* any time, any place. The ability to move rapidly and put out of control provides a down-to-earth deterrent that no aggressor would misunderstand . . .

"The Army is also intensely developing various types of rockets and guided missiles. We have been the pioneers in the field of missiles and are proud of the progress made so far. We already have many units equipped with various types of guided missiles and rockets, and we intend to make the fullest use of scientific improvements now being made in such weapons. The traditional artillery gun may well be on the way to obsolescence, for the new missiles have almost unbelievable possibilities both for antiaircraft and antitank purposes and for all kinds of other enemy targets. The potentialities of such missiles if or when equipped with nuclear warheads of various sizes, stagger the imagination . . ."

General Maxwell D. Taylor, Chief of Staff, concluded the two-day session with a speech entitled, "I'm Glad To Be In The Army." He stated that the Army is not only ready to fight a war wherever it occurs but it is prepared "to fight it on the element where it will end." He continued, "As long as men lead their lives on land, as long as they draw their strength from the earth—in short, as long as they are men—all wars will end on the land; and it is here that the Army, which is the military force designed to gain land objectives, finds its secular justification . . . Not only is the Army prepared to fight the war to the finish on the decisive element, the land, but it is prepared to fight it with discrimination, proportioning destruction to the requirements of the hour. Flexibility is a unique characteristic of Army weapons—its arsenal varies from the MP's pistol to the kiloton blast of its atomic weapons. It is able to distinguish between friend and foe, to adjust the punishment to fit the crime . . . It is able to act with due regard to the postwar conditions which military operations will create . . . because the Army is able to do these things, to contribute to deterrance of war, or if war comes to win that war, I'm glad to belong to it . . ."

The Association was organized in 1950 by the merger of the U. S. Infantry Association and the U. S. Field Artillery Association. In 1955 the U. S. Antiaircraft Association also joined. However, the Association is devoted to advancing the interest of all elements of the Army. It publishes the *Combat Forces Journal*, a monthly magazine. Its headquarters are at 1529 Eighteenth Street, N.W., Washington 6, D. C.

The technical and administrative services of the Army contributed to the meeting principally with static exhibits. These included the extensive exhibit of the Chemical Corps recently completed. Major General William M. Creasy, Chief Chemical Officer of the Army, and a number of his staff attended the meeting. These included Brig. General John R. Burns, commanding the Army Chemical Center, Md.; Brig. General Marshall Stubbs, who heads the Chemical Corps Materiel Command; and Colonel John J. Hayes, commander at Camp Detrick.

MISCELLANY

DR. FROLICH INAUGURATES DETRICK SPEAKER PROGRAM

About 200 military and civilian personnel of the Army Chemical Corps at Camp Detrick, including nearly all of the top staff, turned out August 24 to hear Dr. Per K. Frolich, Deputy Chief Chemical Officer for Scientific Activities and Chief Scientist of the Chemical Corps, speak on "Management Aspects in Research and Development Organizations."

The talk, reported in a release from Camp Detrick, inaugurated a guest speaker program established by the Chemical Corps to bring outstanding men in the fields of supervision and management to Detrick to discuss problems of administration in research and development organizations.

Drawing on more than 30 years experience with industrial firms, Dr. Frolich defined successful management as "influencing people by gaining their respect."

To be a good manager, Dr. Frolich said a supervisor must be fair, sincere and meticulously honest; must take his employees into his confidence and inspire their confidence in return. He said that a good supervisor will take his employees into partnership, give them a full sense of sharing responsibility and will encourage them to contribute voluntarily to the job.

SCENE AT M.C.A. RECEPTION

At a reception of the Manufacturing Chemists Association in the Carlton Room, Sheraton-Carlton Hotel, Washington, D.C., on September 20, honoring General Hull, newly elected President of the Association, are, left to right: John R. Hoover, President of the B. F. Goodrich Co.; J. E. Hull, President of MCA; Charles E. Wilson, Secretary of Defense, and General J. Lawton Collins, U. S. Representative, Military Committee, NATO.

Robert Striar

COL. SULLIVAN NEW DEPUTY

As the JOURNAL went to press information was received that Colonel William E. R. Sullivan has been appointed Deputy Chief Chemical Officer, Chemical Corps. Col. Sullivan has been acting in that capacity since June 1.

GEN. MAAS HEADS DISABLED VETERANS

Maj. Gen. Melvin J. Maas, U. S. Marine Corps, retired, who became blind in 1951, has been made National Commander of the Disabled American Veterans. General Maas is an Honorary Life Member of A.F.C.A. and has frequently been consulted on matters pertaining to the Association interests.

DUGWAY SOLDIER SCIENTISTS TEACH IN LOCAL HIGH SCHOOL

DUGWAY PROVING GROUND, UTAH—Four Dugway soldiers with college degrees in scientific subjects have been selected by the Tooele County School Board to supplement the Proving Ground high school curriculum by teaching for one period each day.

The instructors and their subjects are (left to right in picture above) Private First Class Gilbert Jones, biology; Pfc Carmen Corsi, geometry; Pfc Gilbert R. Seely, physics; and Pfc Frank W. Sinden, French.

The four men are members of a group of more than 100 Chemical Corps scientific personnel on duty at the Dugway testing center under the program of the Department of the Army for utilizing the scientific or professional qualifications of special value to the technical branches of the service.

COL. WALMSLEY HEADS N.Y. PROCUREMENT OFFICE

Colonel Harold Walmsley is shown in the picture below greeting division chiefs upon assumption of command of the New York Chemical Procurement District, which has its offices at 180 Varick St., New York City. This is the largest procurement office of the Army Chemical Corps. Prior to coming to New York last August Colonel Walmsley was Deputy Commander of the Chemical Corps' Material Command in Baltimore, Md.